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Continuous Shop Is Highly Efficient

Among the Advantages To Be Derived from This Type of Foundry Are Increased Tonnage from a Given Floor Space and a Limited Flask Equipment

BY PAT DWYER

CONTINUOUS foundries are by no means an innovation although the recent demand for high production has tended to develop this type of plant design. Opinions have differed as to the real value of continuous molding and pouring, but it is significant that there has been no instance of a foundry using this system, whether erected originally for that purpose, or adapted, which has ever abandoned this method in favor of the old practice whereby all pouring was done at the close of each day. It is true that some classes of equipment which have been installed with the view to permitting continuous operation have been changed. However, the fundamental principles involved have been so universally successful that at the present time a trend toward continuous operation may be noted. In the great majority of foundries now employing continuous molding and pouring, the system was introduced after the plant had been in operation and it had become necessary to attain a greater production from a fixed floor space, although some few plants have been built entirely new, modeled upon the principles of design which earlier continuous foundries have evolved.

One of the earliest pioneers to utilize this mode of operation was the Westinghouse Air Brake Co., Wilmerding, Pa. This company's continuous foundry has been in operation for 30 years and has served as an example for many shops which have been built since. A

FIG. 1—LOOKING DOWN ON CONVEYOR TABLE IN A CONTINUOUS SHOP—THE BATTERY OF PNEUMATIC MOLDING MACHINES AND SAND HOPPERS ARE SHOWN AT THE RIGHT

considerable part of the equipment installed at that time still is doing duty. Individual parts that have worn out have been replaced from time to time, but the ideas underlying the original installation have proved their worth and remain unchanged. That the equipment functions properly may be demonstrated by the company's records which show that castings are produced in the continuous shop at a lower cost per pound than in any of the other foundries operated by the same interest.

In making this comparison it must be realized that no miscellaneous work is made in the continuous shop. The patterns employed are for standard parts for the company's product and it is not necessary to change patterns except at infrequent intervals. Men working on piece work on the same job day in and day out become exceedingly proficient and this factor materially increases the daily output while tending to lower the percentage of defective castings. The equipment was installed by the present general foundry superintendent of the Westinghouse Air Brake Co., Samuel D. Sleeth, who recently completed 50 years continuous service with that company.

The Westinghouse company has found it profitable to operate several foundries in different localities, producing a different class of castings in each. Miscellaneous work is made in one, heavy castings in another, light castings in a third, and medium and light castings which run into thousands and sometimes hundreds of thousands on each order are made in a fourth foundry. This latter plant at Wilmerding is equipped with conveyors and other appliances which make it a continuous molding and pouring shop in every sense. Some time ago when labor was plentiful, the company ran a day and night turn, employing 1100 men in this one shop and charged as high as 420 tons of iron a day. At present only one shift is employed and that not fully manned. The daily charge at present is about 150 tons, distributed between two cupolas. The shop comprises four units all under one roof but operating independently of each other with the exception that the two cupolas each supply iron for pouring the molds in two units.

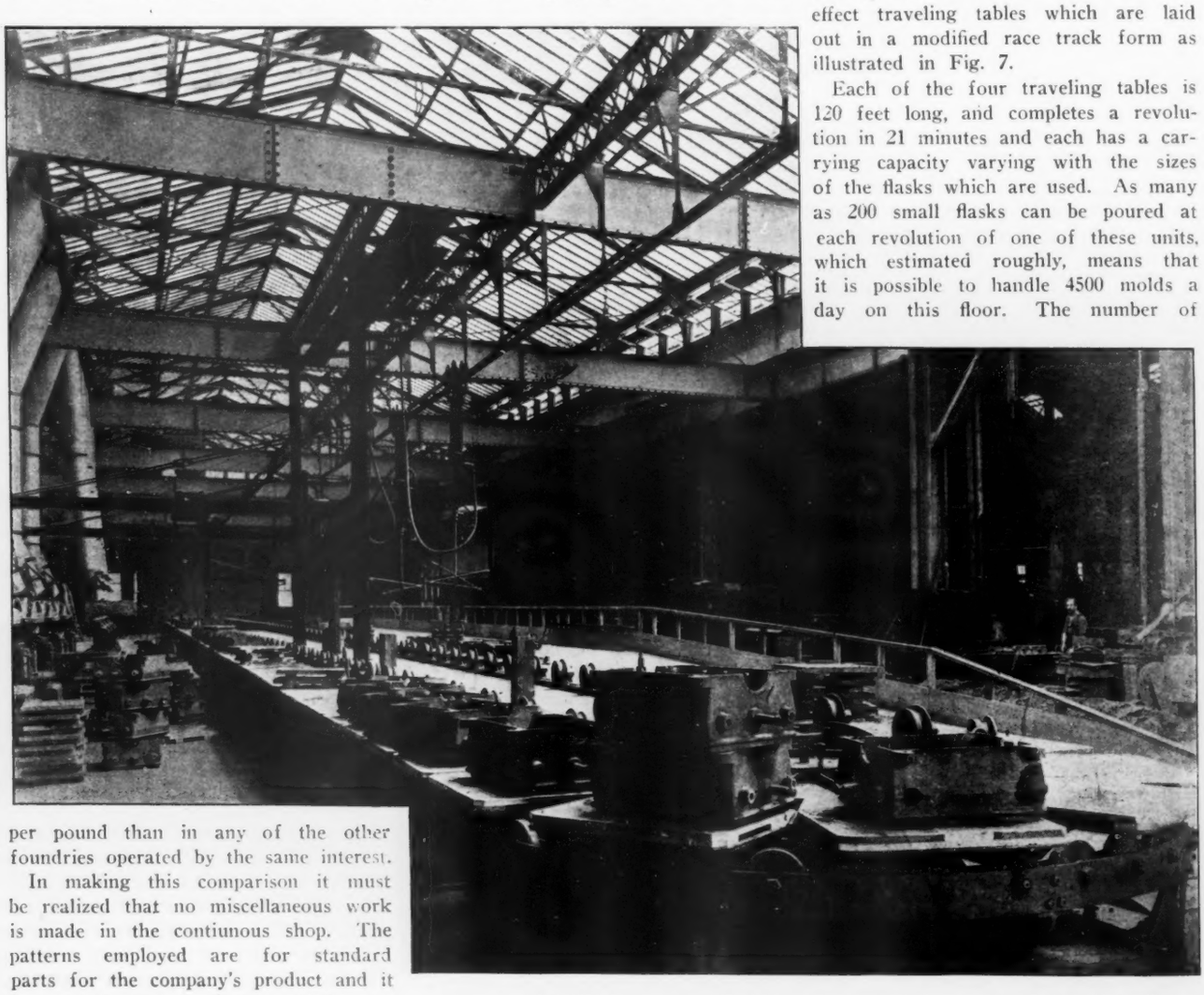


FIG. 2—TABLE SHOWING ROLLER DETAILS AT THE TURN—NOTE THE AMPLE LIGHT AFFORDED BY THE ROOF

Castings are made ranging in weight from a few ounces to several hundred pounds. They are graded approximately by size into four general classes and each class is handled in one of the four units already mentioned. The largest and heaviest castings are made in the first unit, the medium weight in the second and so on to the lightest which are made in the fourth and last unit. Each division mentioned is served by a continuous conveying system which handles the molds from the time they are made, through the coring, closing, pouring, incipient cooling and shaking out operations. The conveyors are in effect traveling tables which are laid out in a modified race track form as illustrated in Fig. 7.

Each of the four traveling tables is 120 feet long, and completes a revolution in 21 minutes and each has a carrying capacity varying with the sizes of the flasks which are used. As many as 200 small flasks can be poured at each revolution of one of these units, which estimated roughly, means that it is possible to handle 4500 molds a day on this floor. The number of larger flasks handled is proportionately smaller.

The driving mechanism for each table consists of a 30-horsepower Westinghouse motor belted to a countershaft running parallel to the line of table travel. A belt from the countershaft drives a pulley on a shaft running under the floor and terminating in a worm which in turn transmits its energy through a worm wheel keyed on the same shaft as a large sprocket wheel. As the sprocket wheel revolves the teeth engage in the cast steel links of the conveyor table. The conveyor consists of a number of boards mount-

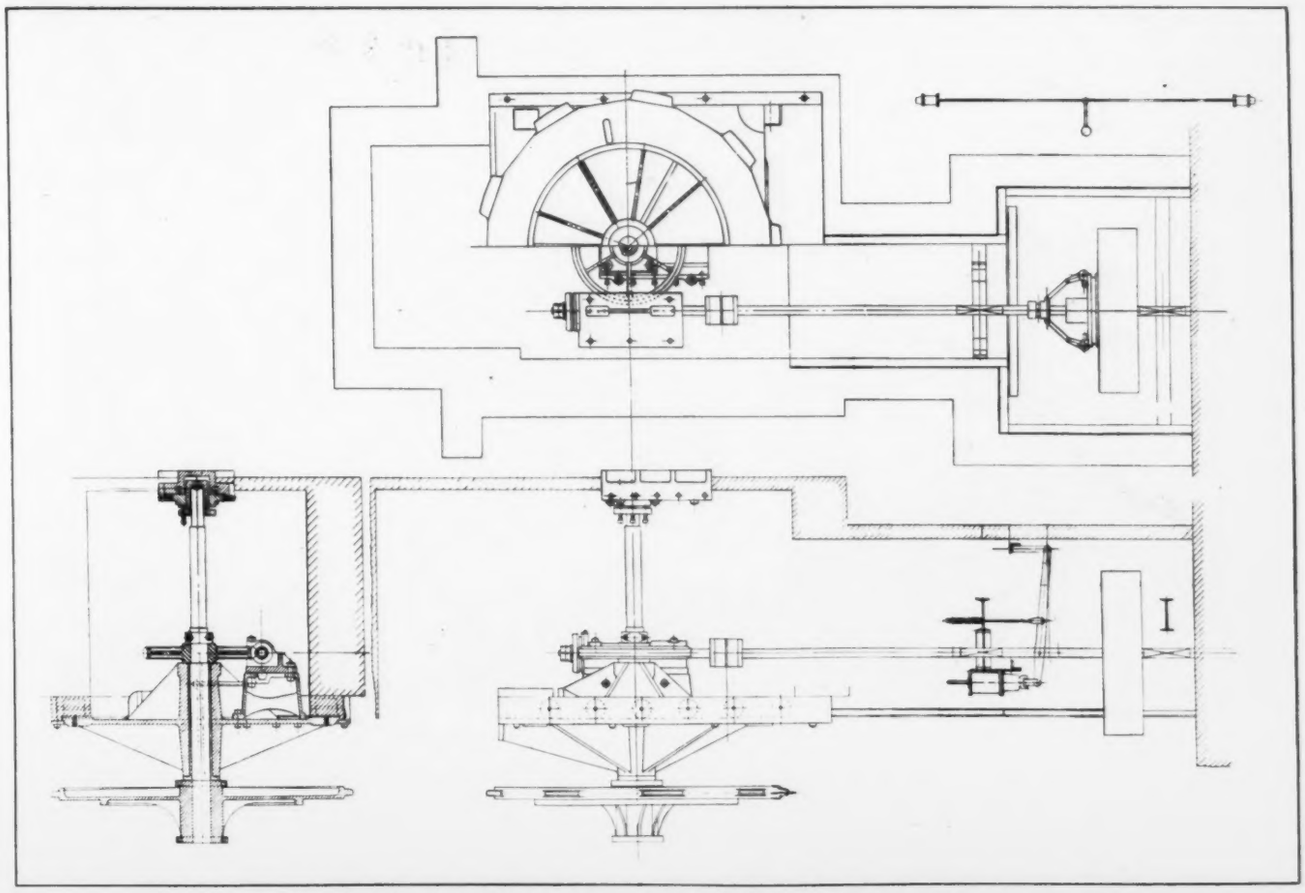


FIG. 3—DETAILS OF DRIVING MECHANISM USED IN THE OPERATION OF THE CONTINUOUS POURING TABLES

FIG. 4—THE FLASKS ARE SHAKEN OUT OVER A GRATING AND PLACED BACK ON THE CONVEYOR—THE SAND IS WET DOWN THROUGH THE RAILED OPENING SHOWN IN THE CENTER OF THE ILLUSTRATION AND THEN CARRIED BY THE BUCKET ELEVATOR ON THE LEFT TO A TROUGH WHICH DISTRIBUTES IT TO THE DIFFERENT MOLDING MACHINES

FIG. 5—THE CLEANING BARRELS ARE ALL PROVIDED WITH HOODS AND DUST COLLECTORS FIG. 6—CLOSE UP VIEW OF ONE OF THE OVERHEAD RECIPROCATING SAND CONVEYORS

ed on a light steel frame work attached to cast-iron rollers on each side which travel on rails. The links under the table are formed of alternate steel castings attached by suitable lugs to the bottom of the conveyor frame and provided on the bottom with cavities which engage the teeth on the driving sprocket wheel; and links made of flat pieces 3 x ½-inch steel plates joined at the ends by ¾-inch pins which fit loosely to allow for freedom of movement.

The pulley at the driving end of the shaft is provided with a clutch coupling and by throwing this clutch out it is possible to stop the travel of the table at any time it may be necessary to do so.

The tables are raised about 2 feet above the floor level. Each consists of three parts, an outside stationary wooden platform on which the men stand or walk when closing or pouring the molds, a center section mounted on a conveyor belt or more properly speaking a steel frame, and a third section, also planked over, which occupies the space within the center of the oval trackway. The illustration Fig. 7 will make the meaning clearer. In this illustration the platform is shown by itself with all the other details omitted and the purpose of each section designated. The point at which the castings are shaken out together with the appliances for doing the work are shown in Fig. 4. A description of the method pursued and the sequence of operations at one of these platforms with some minor modifications for the class of castings handled at each, will serve for all four units.

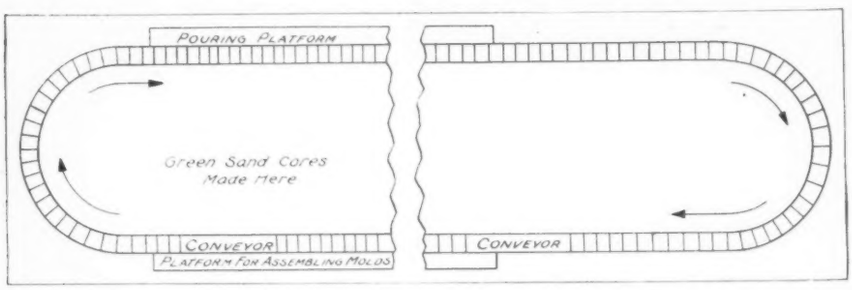


FIG. 7—GENERAL ARRANGEMENT OF CONVEYOR TABLE

A battery of molding machines is situated near the center of one side, separated from the platform by a 6-foot gangway. Consider a typical job, an air brake cylinder for railroad cars. Drags are rammed on six machines and copes on six others. The patterns are mounted on stripping plates and when the flask is rammed the pattern is dropped clear of the mold. The drag is lifted off, rolled over and set on the conveyor.

The cores for this job are made in iron core boxes situated on the wooden platform inside the conveyor belt. Collapsible core arbors keyed by wooden wedges to central pieces of heavy 2-inch pipe are employed. The cores are made of green sand, rammed by hand. A certain amount of skill is required in ramming these cores as the lower surface must be hard enough to withstand the upward pressure of the molten iron and the top must be soft enough so that the iron will not blow or *kick* from it. The necessary skill is acquired in a short time by those without any previous foundry experience. After the cores are rammed, they are lifted out of the core boxes and placed on horses, being supported at each end by the central pipe.

Coming back now to the drag which has just been placed on the conveyor platform; two men lift one of the green-sand cores from the horses and set it in the drag. The pipe projecting from each end of the core fits into openings in the ends of the drag provided for that purpose and automatically locates the core in its proper relative position, assuring an equal thickness of metal at the ends, the sides, the top and the bottom. The conveyor is moving all the while, and after the core is set a cope which in the meantime has been rammed and lifted off the machine, is swung over and lowered onto the drag. This sequence of operations

is kept up all day. A boy standing at the upper turn of the conveyor clamps the flasks as they pass.

Pendant hooks suspended from a monorail extending from in front of the cupola to the pouring side of the conveyor, are employed to support the ladles used in pouring the molds. The ladles at each unit have sufficient capacity to pour several molds at each trip. They are pushed along while pouring, at a speed corresponding to the speed of the conveyor. The melting speed of the cupola also is regulated to keep a constant supply of iron at the pouring station so that the waiting line of molds does not become too long. By the time the molds have traveled the remaining length of the conveyor and rounded the turn at the lower end the castings are cold enough to shake out. A boy stationed at the lower turn knocks the clamps off the flasks as they pass.

Two hydraulic cranes are situated over the lower end of the conveyor and are attached to the flasks by suitable slings just as they come around the turn and start on the journey toward the point where they were first placed on the platform. The crane picks up the complete mold and drops it with a bump on the rails shown in the illustration Fig. 4. The cope is lifted off and if necessary given another bump on the rails. The drag is then turned over and the casting rolls down the inclined ends of the rails. From there a man with a long hook pulls it away to a cooling floor where it remains until it is cold enough to be taken and put in one of the tumbling barrels where the castings are cleaned. Before going in the tumbling barrels the core sand is rapped out and the collapsible arbor removed piece by piece through the small openings in the ends of the casting.

After the sand has been bumped out, the cope and drag are set on the conveyor which carries them to a point in front of the molding machines. A sufficient stock of flasks is maintained at this point so that the latest arrivals have time to cool before again being placed in service. At no time do the flasks become so hot that they could not be used immediately if necessary, but allowing the flasks to cool adds to the comfort of the men, especially in the summer time.

The two heavy work units are served by a total of 24 hydraulic molding machines which were built by the company in its own shops. The action of these machines is controlled by a special intake and release valve which gives a combined squeeze and jolt pressure to the sand forming the mold. On large flasks, say 3 x 2 x 1½ feet, the plunger carrying the table which supports the flask is forced up against the squeezer plate three or four times. After each upward move, it is dropped back quickly, thus jolting the sand adjacent to the pattern plate. It is claimed that this results in a more even density of sand in the flask than if it had been simply jolted from the bottom or squeezed from the top alone.

Air brake cylinders and work of a similar character are regarded by foundrymen, as fairly hazardous, requiring skilled molders and the closest supervision over the character and composition of the iron with which they are poured. The molding process at the Wilmerding plant has been so standardized that ordinary labor may be instructed in a short time to perform any of the subdivision operations into which the processes have been reduced. The castings must be clean,

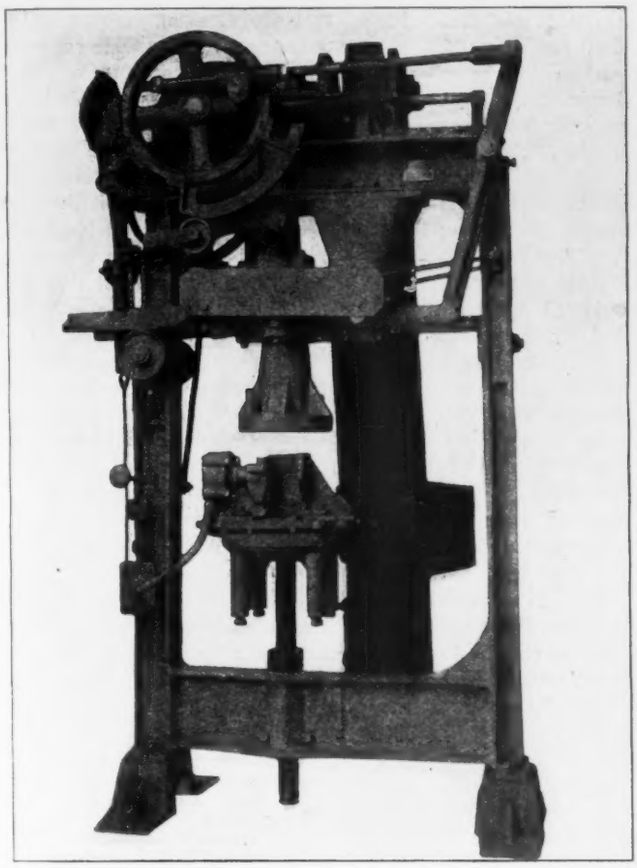


FIG. 8—CORE-MAKING MACHINE WHICH DRIVES THE SAND INTO THE CORE BOX WITH THE AID OF COMPRESSED AIR

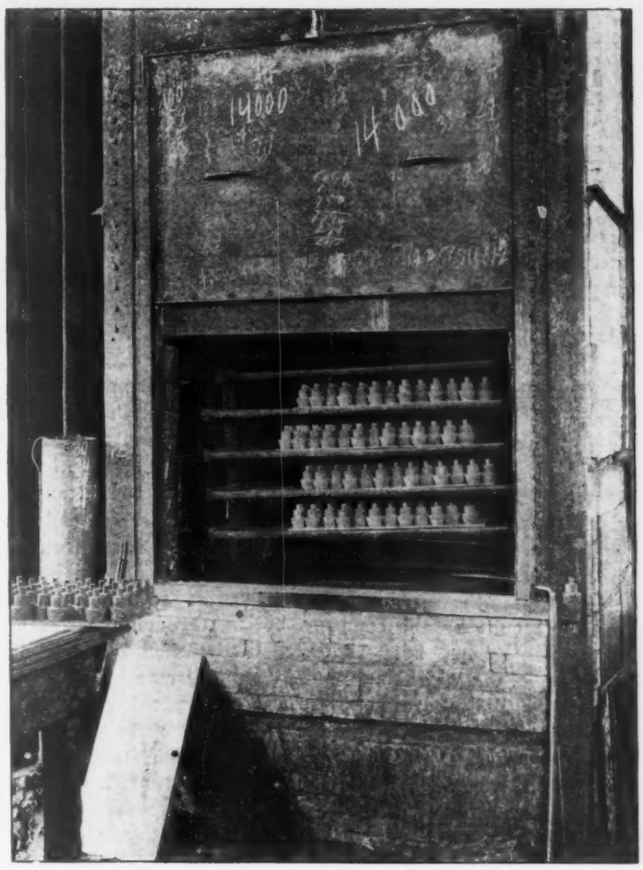


FIG. 9—THE SHELVES ON THIS CORE OVEN ARE ATTACHED TO A SPROCKET CHAIN WHICH TRAVELS APPROXIMATELY 20 FEET VERTICALLY—A GAS BURNER IS SITUATED ON THE FLOOR OF THE OVEN—ONE REVOLUTION DRIES THE CORES—THEY ARE PLACED ON THE SHELVES THROUGH ONE DOOR AND TAKEN OUT THROUGH A DOOR AT THE OPPOSITE SIDE

solid and must conform to a certain definite weight. Therefore, it is essential that no disturbance occur while the molten metal is filling the mold. Cuts, blows, scabs or porous spots due either to wet sand or hard ramming would be disastrous and are provided against by careful supervision of the sand mixing equipment and by adjusting the intensity of the stroke delivered by the molding machines. Once the machines are set to ram the sand to a given density, the human factor is eliminated and every mold is rammed to exactly the same pressure and compactness.

Use Hydraulic Machines

The hydraulic equipment, which was installed by the Morgan Engineering Co., Alliance, O., comprises an accumulator capable of withstanding a pressure of 1250 pounds per square inch; one steam pump with three 7/8-inch water pistons made by the Buffalo Pump Co., Buffalo; one steam pump with three 1/2-inch pistons made by the Worthington Pump Co., New York; and three electric pumps with 2 3/8-inch pistons made by the Deming Pump Co., Salem, O. Twenty-four molding machines derive their power from this installation. The hydraulics were the first type of molding machines installed and this may account in some measure for the partiality of the company for this type. Another reason may lie in the fact that the machines were designed and built by the company itself, in its own shops but whatever the reason, the fact remains that these hydraulic machines are highly efficient.

The air compressor installation which serves the pneumatic molding machines at the tables where the small molds are made, is capable of delivering 4640 cubic feet of air per minute. The air supply of course also is available in the cleaning room and for some special machines in the core room. Iron flasks are used exclusively and while those used on two of the tables are light enough to be moved by hand, those on the other two tables are entirely too heavy to be handled in that manner.

The principal difference between the operation of the light and heavy floors is in the manner of shaking out the molds. In the former, a man is stationed near the conveyor a short distance from the pouring stand and as the molds pass he slips the end of a long steel bar between the drag and the bottom board. By jerking down sharply on the outer end of the bar and using the edge of the conveyor as a fulcrum he is enabled effectually to loosen the complete mold. A second man stationed a little farther along lifts the empty flask and sets it further back on the conveyor and with a long hook he jerks the casting from the conveyor to the floor. The castings are stacked in a huge pile and allowed to cool before being taken to the cleaning room.

When the flasks are shaken out the sand falls through a grating similar to that shown in Fig. 4, onto a wide moving belt. A man seated by the railed enclosure manipulates a hose and sprinkles the sand as it passes by below him. The belt discharges into a pocket from which a bucket elevator, also shown in the same illustration, carries the sand and drops it into a long trough which extends over the hoppers serving the different molding machines. A reciprocating type sand conveyor, the details of which are shown in Fig. 6, is used for moving and mixing the sand. The scrapers on the conveyor are hung from hinges which enables them to swing freely on the back stroke, but a suitable stop at the back holds them rigid when the conveyor is moving ahead. The conveyors are driven by individual Westinghouse motors, the rotary motion being converted into reciprocating by a belt and counter shaft, and a suitable crank connection. As a further proof that the flasks do not become hot on their passage from the pouring stand to the shaking-out floor, it is stated that the sand is only 20 minutes in transit between the shaking out screen and the molding machines and yet no trouble is experienced from its being too hot. New sand is added at regular intervals. This is thrown through the screen where the flasks are shaken out and thus has a chance to become thoroughly incorporated with the old sand before it finally reaches the molding machines.

The castings are tumbled in a battery of barrels of different sizes but all conforming to the general features of the one shown in Fig. 5. Owing to the bulky character of most of the material to be handled, the staves are extra strong and substantial. An interesting feature in connection with these tumbling barrels is the dust collecting hood which encloses each one. The body of the hood is formed of thin plate; but the door which slides up and down in front is made of wood fitted into an agle-iron frame. Each hood is provided with a 6-inch opening at the top through which the dust is drawn by a suitable fan and system of piping leading to several dust arresters while the mill is in operation. After the castings are cleaned they are removed from the barrels and whatever chipping is necessary is attended to in a space set apart for that purpose at one end of the foundry. They are then ready for shipment to one of the company's numerous machine shops.

The core room is situated upstairs in a building adjacent to and opening directly into the foundry. The lower floor is occupied by a general store room, a locker and wash room. In addition to the regular methods of making and drying cores consisting of hand rammed coreboxes and drawer-type horizontal ovens, there is in operation, and has been for several years, a vertical core oven which dries the cores in one revolution, and a core making machine made by William Demmler & Bros., Kewanee, Ill., which employs compressed air to shoot the sand into the box and pack it there. This latter machine is exceedingly fast, being capable of making eight complete cores a minute and has a wide range of adjustment. It makes cores from 1 inch to 14 inches in length and will fill boxes requiring as much as 200 cubic inches of sand. It is provided with a sand elevating and feeding device which insures a proper quantity to suit the core that is being made. It is claimed that cores made on this machine are naturally vented, the theory being that the surplus air escaping from the core immediately after the box is filled leaves the core porous yet firm and strong. Cores may be made of sharp sand, loam sand or green sand and any binder may be used except flour, which must be used sparingly. For sharp-sand cores the machine operates satisfactorily at 80 or 90 pounds pressure, but loam-sand mixtures require from 100 to 115 pounds pressure.

The cupola platform is provided with several tracks and the coke and iron is shunted by a locomotive crane in carload lots from the stock yard. On the platform the pig iron charges are made up on buggies which are weighed and afterward pushed close to the charging doors where the material is charged by hand. The scrap is charged through an upper door by means of a buggy which is lifted on an hydraulic hoist and tipped when it reaches the door.

Under New Management

The Northern Iron & Steel Co., Chicago, recently has taken over the Beckemeyer Foundry Co., Beckemeyer, Ill., and will operate it as the Beckemeyer foundry branch of the Northern Iron & Steel Co. The plant consists of a gray iron foundry and pattern shop.

The Eastern Foundry Co., Jamesburg, N. J., which recently changed management, is producing piano plate for the market. Thomas Watts, Matawan, N. J., is president of the company, and Harry Bolt, formerly with the Matawan Iron & Steel Co., is in charge of operating.

Fabricating Steel Foundry Flasks

Rigidity Is Obtained by Forming Ribs on 3-Inch Centers — Bottom Half of Each Rib Is Made Shallow to Provide a Shoulder Upon Which the Sand Rests — Diversified Uses of Flasks

BY J. D. KNOX

CONCURRENTLY with the development of mass production in the automotive industry came a transformation in the methods of manufacturing the various parts which comprise the complete motor car. These changes affected practically all processes, including that of producing castings. Foundrymen who previously had received orders involving hundreds of castings from a single pattern were compelled by the demands of automobile builders to seek equipment suited for the economical production of thousands of identical castings.

The new requirements were met by adopting machine molding on a more extensive scale and by employing more durable patterns and molding flasks. Cast and pressed steel came into widespread use and at the present time practically all of the engine castings and most of the other cast parts of automobiles are poured in metal flasks. Because of their lightness, rigidity and durability, pressed steel flasks are being used for molding automobile pistons, flywheels, truck wheels, rear axle housings, tractor parts, etc.

Among the companies which recently have engaged in the manufacture of steel flasks is the Truscon Steel Co., Youngstown, O. Stock from which the flasks are made is copper-bearing, open-hearth, medium blue annealed

FIG. 1—FLASK, WEIGHING 87 POUNDS, USED EXTENSIVELY IN MALLEABLE FOUNDRIES

plates, 60 x 100 inches. It is rolled by outside mills in thicknesses of $\frac{5}{32}$, $\frac{3}{16}$, $\frac{7}{32}$ and $\frac{1}{4}$ inch. Upon delivery to the Truscon plant the steel is piled in a warehouse, which is built at right angles to the building housing the pressed steel department. An electrically driven shear, equipped with an adjustable stop gage on the back table, is built at the end of the warehouse nearest the pressing department. The plates are taken from the stock pile as required, and transferred to the shear.

After the cut is made the blanks are piled on a steel platform and taken to a large press in the forming department where the first operation is performed. This consists of stamping one or more ribs on 3-inch centers according to specifications. Sections 3 inches high are made with one rib, sections 6 inches high with two ribs, etc. Where a section is built with two or more ribs, the latter are pressed in the metal one at a time in order to avoid stretching the steel. The top half of each rib is made with a steep slope in order that the sand will slide in position easily when the flask is placed in service; the bottom half of each rib is made shallow and acts as a shoulder, upon which the sand rests.

To provide a place for clamping the cope to the drag and to permit the ramming of sand without interference, the practice followed by the company is to turn the top flange of the cope and the bottom flange of the drag outward and the sand strips inward. Some users, however, desire both flanges turned inward. After the flanges have been formed the next operation is to turn the corners. Before this can be done, however, it is necessary to anneal the steel at the place where the bend is to be made in order to relieve the hardness introduced to the steel during the forming operation. The steel is removed from the flanging press, placed on the floor and the flanges heated with an oxygen-acetylene gas flame. The die used for turning the corners is of the built-up type and affords the stamping of any number of ribs of any width. Round flasks are formed in a similar manner

FIG. 2—MAIN AISLE IN THE PRESSED-STEEL DEPARTMENT OF THE TRUSCON STEEL CO., YOUNGSTOWN, O., SHOWING THE DIVERSIFIED LINE OF PRODUCTS MADE

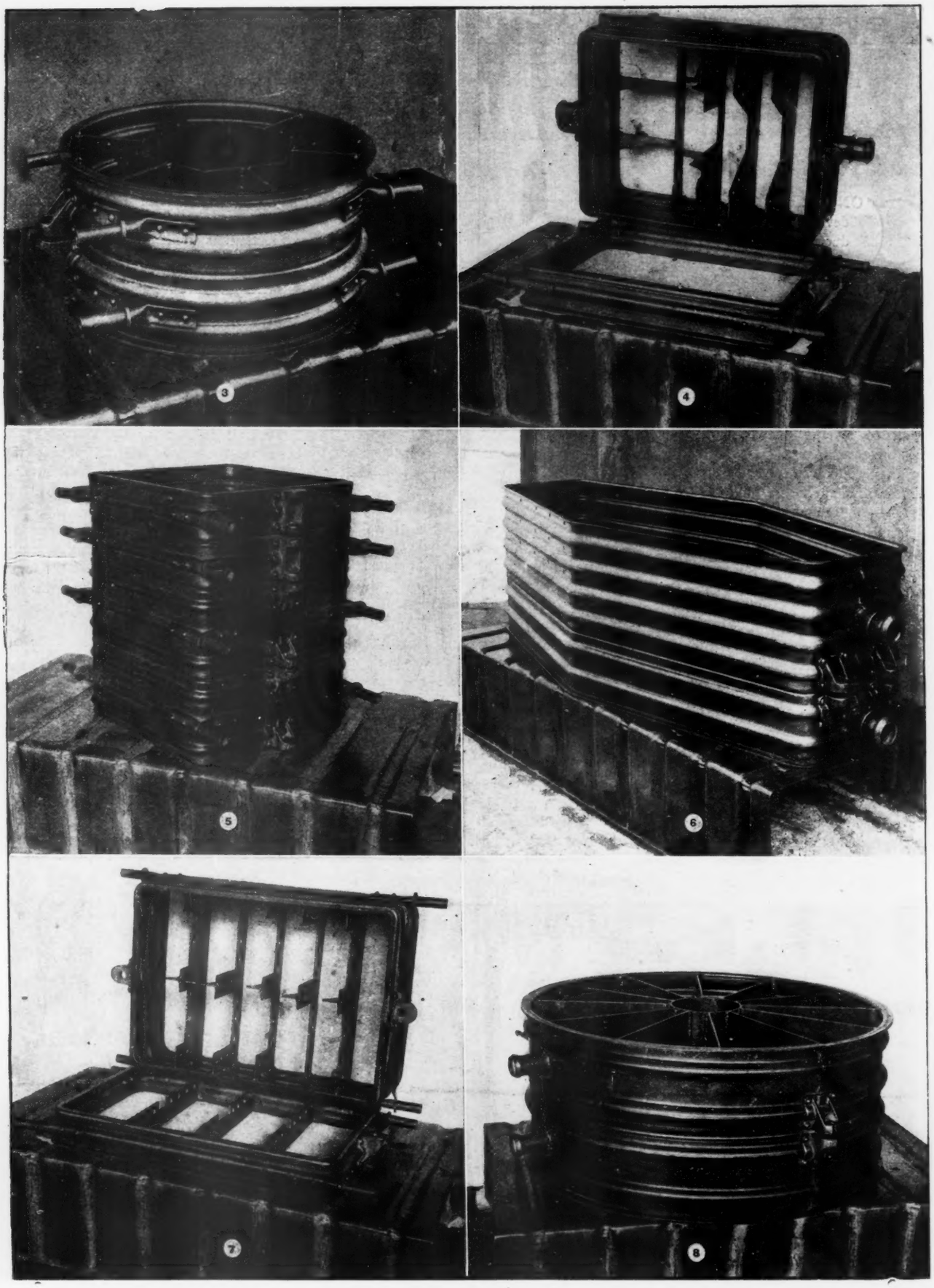


FIG. 3—CIRCULAR-TYPE FLASK ILLUSTRATING TYPICAL BARRING CONSTRUCTION FIG. 4—WHEN FLASKS OF THIS TYPE ARE EQUIPPED WITH TRUNNIONS, PIPE SOCKETS ARE USED INSTEAD OF HANDLES FIG. 5—FLASKS OF THIS TYPE ARE USED FOR MISCELLANEOUS WORK AND ARE PROVIDED WITH DOWEL-PIN BRACKETS SO THEY CAN BE BUILT UP TO ANY DESIRED DEPTH FIG. 6—FLASK USED FOR CASTING REAR AXLE HOUSINGS FOR TRUCKS FIG. 7—FLASK USED FOR CASTING TRACTOR PARTS FIG. 8—CIRCULAR FLASK, WEIGHING 208 POUNDS, USED FOR CASTING TRUCK WHEELS

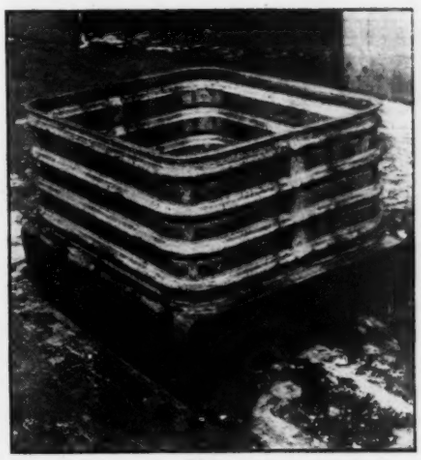


FIG. 9—PRESSED-STEEL BOX AND PLATFORM USED FOR HANDLING SMALL PARTS

as the square types with the exception that the built-up die strikes each half section three or four times while only one stroke is required to round the corners of the square flasks.

After the corners are rounded the shells are inspected, matched, and taken to assembly benches where two sections are clamped together to form the flask. In this condition they are transferred to the welding shop which is housed in a separate building off the pressing department. The welding department is equipped with eight electric welding machines, these being operated in individual compartments. At this stage in the process of manufacture only the inside seams are welded. The flasks then are taken to the drill presses where four holes are drilled in the center of each end for the dowel brackets and four additional holes near the rounded corners for the handle and handle bracket. The dowels, which are made of malleable iron, then are drilled and the whole taken to the riveting department where the handles and brackets are attached with ⅝-inch rivets driven hot. Gas muffle furnaces are used for heating the rivets.

The stock then is returned to the welding department for welding the cross bars in place. Prior to this step, however, the bars are lined up by a jig. Certain foundrymen order their flasks with the bars welded on one side and riveted on the other. Ordinarily the bars are welded in place. Several types of flasks, particularly those of heavy construction, are equipped with trunnions, which are formed from 2-inch steel pipe with collared ends. A heavy ring is welded in the center of each trunnion to form a second collar and the whole welded to the sides of the flask. Malleable-iron trunnions originally were used but when shipments of the castings became difficult, officials endeavored to find a substitute. A flask was equipped with welded steel trunnions and after being loaded with two tons of steel, the whole was lifted by a crane, the trunnions bearing the entire weight. As no deflection of the trunnions or walls of the flask was noticed the test was carried further by hammering with a heavy sledge. Numerous blows failed to break the trunnions at the weld although they did cause the trunnions to break a short distance away. Four short steel pipes, 1-inch in diameter, are welded to the corners of the flasks equipped with trunnions to afford easy handling. In preparing these handles they first are heated to the desired temperature in a gas-fired muffle-type furnace, and then taken to a small press, which flattens and grooves one end. The grooved end is welded to the side of the flask, the open end of the pipe forming the handle.

After any extra metal due to the welding process is ground off, the flasks are transferred to a table where by means of jigs the dowel pin holes are accurately drilled. The holes then are reamed. At the beginning of the fabricating process the flasks are made ⅛-inch higher than specifications, in order to provide enough leeway for flattening upon completion of the work. The final pressing of the flask to make it conform to specifications removes any twists and leaves the sand strips smooth. Any dents in the sand strip, which the press fails to remove, are eliminated by hammering when the flasks arrive at the inspection benches. After a rigid inspection the flasks are shipped.

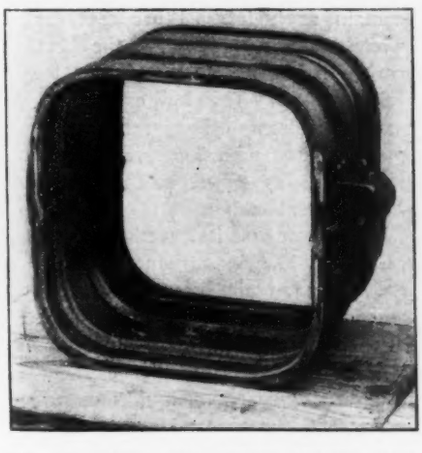


FIG. 10—FLASK, 13¼ INCHES SQUARE, USED IN MAKING AUTOMOBILE PISTONS

FIG. 11—CIRCULAR-TYPE FLASK, 17 INCHES DIAMETER, USED IN MAKING AUTOMOBILE FLYWHEELS

FIG. 12—COPE, 4½ INCHES, AND DRAG, 3 INCHES, BOTH WEIGHING 45 POUNDS USED FOR MAKING AUTOMOBILE FLYWHEELS

Before any actual work is begun on the flasks, blueprints are prepared by the engineering department of the Truscon company and forwarded to the customer for his approval. Where an order embraces flasks which are to be equipped with bars, the customer usually furnishes wooden patterns together with templates, these aiding in the preparation of accurate drawings and in a more prompt completion of the order.

Fig. 6 shows a double tapered flask made from ⅜-inch plates and weighing 225 pounds. The cope is 12 inches and the drag 7 inches. Flasks of this type were built for use in casting rear axle housings for automobile trucks. The shell of the flask is drilled to receive cast-iron bars for the various types of axles made. The tapered flask shown in Fig. 13 was made for casting the dash of a tractor.

The flask shown in Fig. 1 is 19 x 19 inches inside the sand strip and includes a 4½-inch cope and a 14½-inch drag. It is made of ⅛-inch stock and

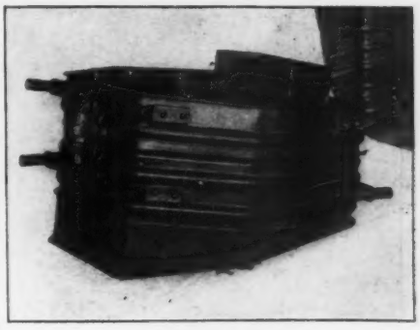


FIG. 13—IRREGULAR-SHAPED FLASK, WEIGHING 120 POUNDS, USED FOR MAKING A TRACTOR DASH

weighs 87 pounds. Prior to shipment all copes were drilled for bars, which were to be cast and bolted in place by the customer. Quarter-inch plates were used in making the flask shown in Fig. 4. The total weight is 195½ pounds. The arrangement of the bars in the cope is typical of many orders received by the Truscon company. Practically all flasks equipped with trunnions have pipe sockets instead of handles welded on the cope.

The type of flask shown in Fig. 5 is used extensively by a manufacturer of electrical equipment. The size is 18 x 18 inches, the various sections being 4 and 7 inches high. Inasmuch as the flasks are used for miscellaneous work in the foundry both flanges are turned inward. In addition the flasks are provided with dowel-pin brackets at both the top and bottom in order that the flask may be built to any desired height. Fig. 7 shows a 19 x 28-inch flask with a 9-inch cope and a 3½-inch drag, which was made for a tractor company. The illustration shows the method employed for attaching the bars to the sides of flasks intended for special jobs. The cope and drag shown in Fig. 3 each are 20¾ inches diameter and 5½ inches high. Flasks of this type also are used extensively for making tractor castings.

A large number of flasks similar to the one shown in Fig. 12 are in service in plants making flywheels for automobiles. They are 17 inches diameter and include a 4½-inch cope and a 3-inch drag, the whole weighing 45 pounds. The flask shown in Fig. 8 was made for casting truck wheels. It is 36 inches diameter with an 8-inch cope and an 8-inch drag and weighs 208 pounds. The circular flask illustrated in Fig. 11 also is for making automobile flywheels. The square type flask, Fig. 10, is used for making automobile pistons.

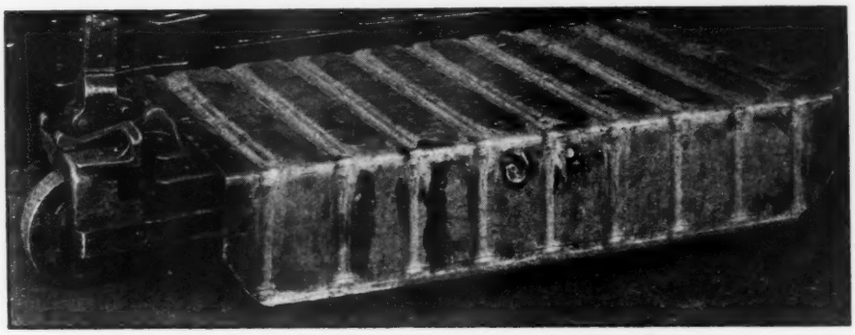


FIG. 14—PRESSED-STEEL PLATFORMS USED IN CONJUNCTION WITH ELECTRICALLY AND HAND-OPERATED LIFT TRUCKS—THE PLATFORM IS OF ONE-PIECE CONSTRUCTION

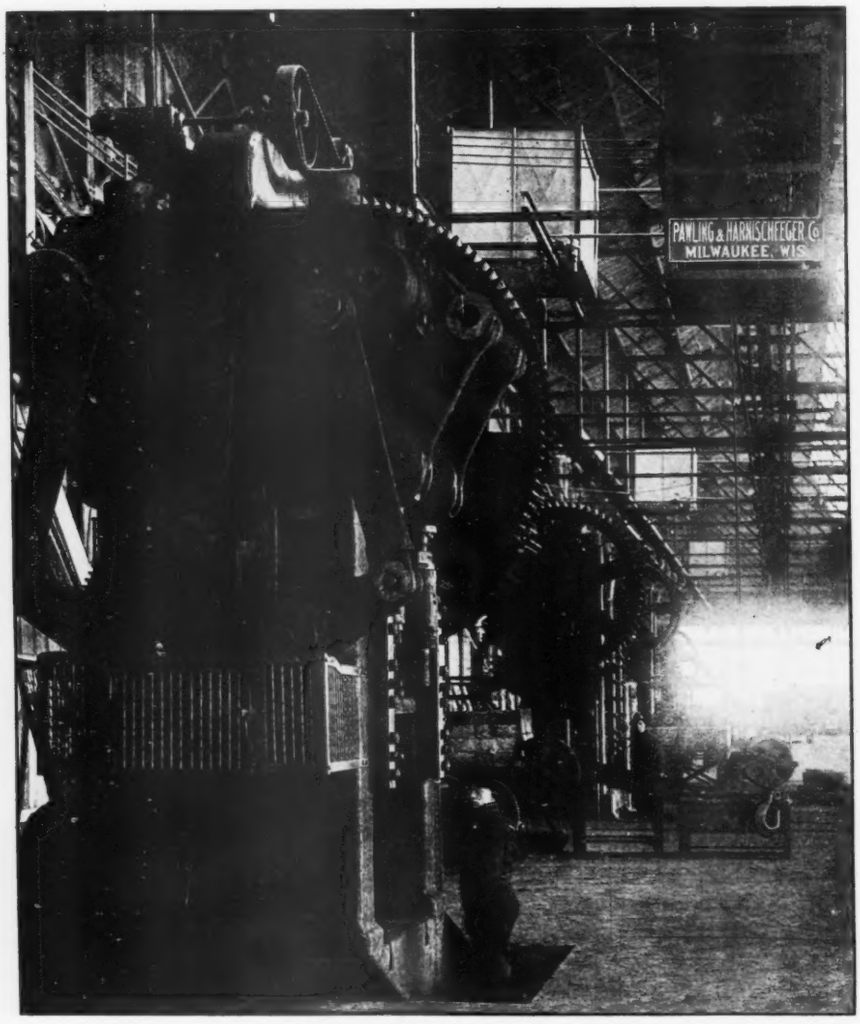


FIG. 15—A BATTERY OF HEAVY TOGGLE PRESSES INSTALLED ALONG THE LEFT-HAND SIDE OF THE PRESSED-STEEL DEPARTMENT OF THE TRUSCON STEEL CO.

Securing Low-Carbon Cast Iron

By H. E. Diller

Question—Please inform me how I can reduce the carbon in cupola iron. It now averages 3.50 per cent and I would like to reduce it to 2.70 per cent. Could I do this by adding steel to the charge in the cupola?

Answer.—There is no satisfactory way of obtaining, with regularity, low-carbon iron from the cupola. The addition of steel scrap in small quantities would not make a material difference as the steel would take up carbon from the coke in the cupola.

One foundry with which the writer was familiar used a mixture consisting of one-half 8 per cent ferrosilicon and the remainder steel scrap. The ferrosilicon contained about 2 per cent carbon and the steel scrap averaged 0.40 per cent carbon, so that the average of the charge was about 1.20 per cent carbon, as the mixture went into the cupola. When the iron came from the cupola the percentage of carbon varied greatly from one part of the heat to the other. The iron from the first of the heat would contain as high as 3 per cent carbon, while towards the last of the heat the carbon in the metal might be as low as 1.80 per cent. This low carbon did not greatly increase the strength of the metal as iron with 3 per cent of carbon was nearly as strong as that with only 1.80 per cent carbon.

The most practical method to obtain cast iron low in carbon would be to melt it in an air furnace and add any amount of steel scrap necessary. It also could be secured by adding molten steel to the iron from the cupola. This could be done by melting the steel in a separate furnace and adding it to the metal from the cupola in a ladle. By either of the two methods the amount of carbon could be controlled.

Irons for Diesel Engine Castings

The Results of an Extended Series of Experiments Point to the Fact That the Proper Iron Composition is the Most Important Factor in the Manufacture of These Prime Movers

BY F. J. COOK

CONSIDERING the fact that everyone who has had to do directly with the manufacture of diesel engines is convinced that the metallurgical side of the question is one of vital importance, it is remarkable that among the host of papers written on the subject of this type of prime movers few have made any attempt to deal with the casting problem. This paper deals only slightly with design and that only as it affects the metallurgy of the subject but concerns itself more fully with the items which are essential in the production of satisfactory castings.

The growth of cast iron due to repeated heating has been made the subject of investigation by several well known authorities and it has been proved that growth is largely due to the influence of gases which penetrate the cast iron by way of cavities formed by large graphite flakes or loosely intermixed crystals of the metal. It follows therefore that anything which favors either of these undesirable conditions is essentially detrimental to success.

The planes of crystallization in cast iron when it is passing from the molten to the solid state, group themselves perpendicularly to the surface of the external contour, that is to say at right angles to the outside surface and in the direction in which the heat of the fluid cast iron has passed outward. Every abrupt variation in the external contour of a casting, no matter how small, is attended with an equally marked sudden alteration in the arrangement of the crystals of the metal. A confused and irregular formation of crystallization occurs in the neighborhood of each such point of variation. The proper interlocking of the crystals is prevented, resulting in weak and open structures if not actual cavities. Some castings of this character, on account of the static pressure of the metal in the mold when casting, or some other cause, artificial or accidental, do not show these weaknesses in any marked degree; but when such castings are exposed to repeated heatings the crystals change position and form the same loose and confused mass, with the consequent weakening of the structure.

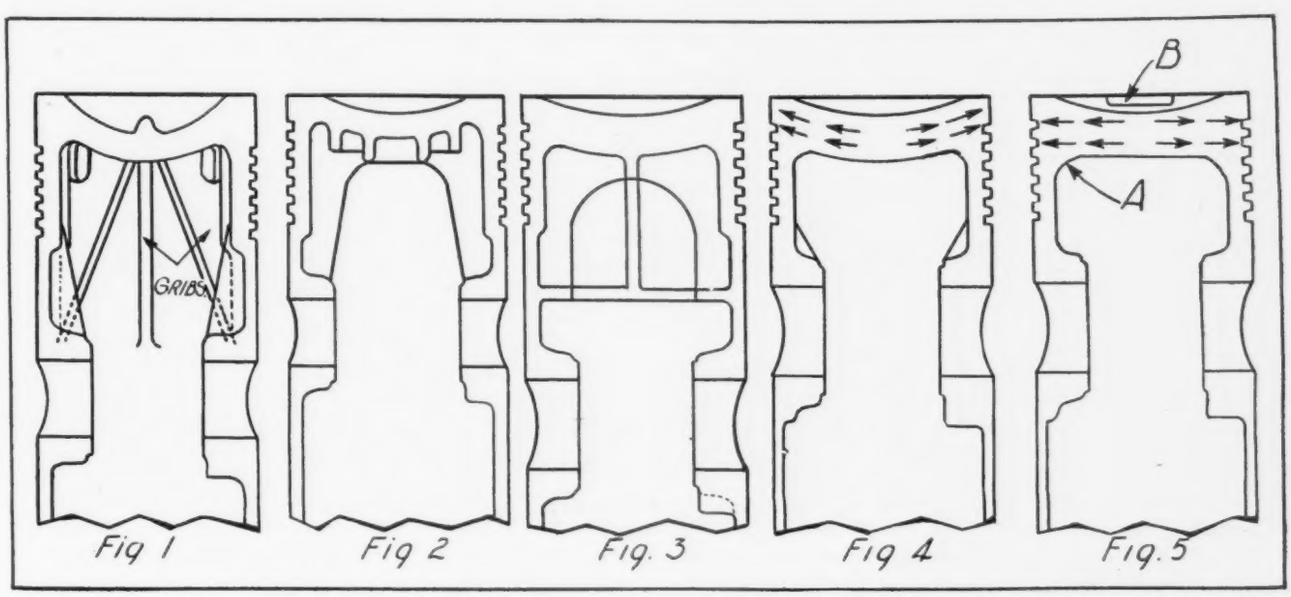
The natural remedy for the conditions outlined is to so design the casting as to avoid all sharp angles, ribs and sudden deviation of sectional outline so that the metal while being poured will flow in natural curved lines. These remarks apply to castings in general but the matter is of primary importance in the design of diesel engine pistons and cylinder heads. It is apparent that the pistons shown in Figs. 1, 2 and 3 are not only subject to the effects of bad crystallization, but also have the dis-

TABLE I

Comparative Analysis

	Suggested by Hurst Per cent	German Per cent	Another German Per cent	Continental Per cent	Replaced by Per cent	Scotch Per cent	Suggested by the author Per cent
Phosphorus ...	0.52	0.33	0.59	0.54	1.34	0.54	not over 1
Manganese ...	1.44	0.72	0.99	1.08	0.28	0.97	not over .5
Silicon	0.9	0.83	0.91	0.92	0.8	0.77	0.76–0.82
Results.....	....	good	bad	bad	good	good	Has never given star cracks, low tensile results, or bad wearing qualities.

Abstract of paper presented by F. J. Cook, Birmingham, before the North-East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne, Jan. 30, 1920.



REPRESENTATIVE TYPES OF PISTONS USED IN DIESEL ENGINE CONSTRUCTION—THE MANY RIBS AND BRACKETS IN FIGS. 1, 2, 3 AND 4 CAUSE INITIAL COOLING STRAINS AND PREVENT HOMOGENEOUS CRYSTALLIZATION—THE IDEAL DESIGN IS SHOWN IN FIG. 5

advantage of being subjected to high initial cooling strains which further increase the liability of cracking when in use. An improved design shown in Fig. 4 has been quite successful in ordinary work. A further improvement has been effected by designing the under side of the head straight as shown in Fig. 5. This type has given excellent

FIG. 6—TEST BAR TO DETERMINE CASTING TEMPERATURE

results during the war in submarine work. It is essential that there be a good easy angle at the point marked *A* to avoid a too abrupt change of section. An angle at the bottom of the cutaway *B* is also desirable, it will prevent a crack from starting at that point.

Every process in manufacture that facilitates closing the grain should be taken advantage of. Cylinder liners and pistons should be cast on end to get the benefit of the static pressure of the metal in the mold. Denseners have been used for improving the compactness of the piston head but their use requires special care or the castings will be too hard.

A cast-iron piston, if too hard, has a tendency to split right across when first put to work, particularly if subjected to full load soon after starting. A tough iron is therefore most desirable.

Determining Factors

Properties of cast iron essential to successful working of diesel engine pistons and liners are: High tensile and other physical traits; metal which will readily take a high polish under working conditions; and the ability to resist growth and cracking when subjected to the high working temperatures which are a feature of this class of engine. The factors which determine these conditions are: Chemical composition; casting temperature; rate of cooling; microstructure. It is essential that the rate of cooling be taken into account when considering the chemical composition of metal to be employed in any casting.

It is not too much to say that all the physical properties of the metal depend on the quantity of carbon present and its condition. The value of the other elements will be in proportion to the effect they have on carbon and the compounds it forms. Professor Turner states (Metallurgy of Iron) that maximum tensile strength is associated with 0.47 per cent combined carbon and maximum transverse strength with 0.7 per cent. The experience of the author of this paper, however, leads him to the conclusion that these figures should be reversed for present day practice; maximum tensile strength being obtained with 0.6 to 0.8 per cent and maximum transverse strength with 0.4 to 0.6 per cent, and with total carbon not exceeding 3.25 per cent.

Silicon is always present in varying proportions. The influence it exerts on the condition of the carbon present and consequently on the hardness and fluidity of the iron is marked. Since the quantity and condition of the carbon are so important and the effect of the silicon on this element, so marked, it is clear that if a formula can be adduced that will show when these two elements are in the best proportions for a given class of work, a very important stage will have been reached. With this object in view the following more or less empirical formula is presented based on the amount of carbon:

$$Sc = 4.26 - \frac{Sil}{3.6}$$

Where Sc = ratio of silicon to carbon; C = total carbon in percentage; Sil = silicon in percentage. The elements carbon and silicon are in the best proportion for diesel engine pistons and liners and all parts requiring highest tensile strength when the value of Sc = 0.76 to 0.82; and for water cooled cylinder heads and castings requiring maximum transverse strength when the value of Sc = 0.83.

The presence of sulphur makes the molten metal thick and sluggish and promotes blow holes, but this element in fair proportions, say 0.12 per cent, adds considerably to the wearing properties and strength of the metal. It is necessary, however to cast sulphury iron as hot as possible.

There are many who think it impossible to produce strong iron unless the percentage of phosphorus is very low. To lower this element they frequently resort to hematites, but these, with their high percentage of total carbon often do more harm than a liberal dose of phosphorus. When the proportion of total carbon and silicon correspond to the formula presented earlier in this paper, the proportion of phosphorus may be as high as 1 per cent, without seriously jeopordizing the tensile strength. With steam cylinders and castings of complicated design requiring maximum strength, the reduction of shrinkage and the additional fluidity of the metal due to the high phosphorus content will result in sounder castings, with fewer initial contraction strains. Where the ratio of silicon and carbon is different from that which has been suggested the quantity of phosphorus becomes a vital factor and must then be kept as low as possible.

Table No. 1 goes to show that where the silicon and carbon are in the desired ratios, the quantity of phosphorus present does not affect the quality of the casting.

TABLE II

Result of Annealing

Test No.		Tensile strength Pounds per square inch	Transverse strength Pounds, 1-inch square bar, 12-inch centers	Impact	Hardness
1	As cast	39,080	3976	65	77
	Annealed	30,688	3584	60	44
2	As cast	37,856	3500	75	84
	Annealed	30,240	3080	50	39
3	As cast	39,872	3780	70	80
	Annealed	30,844	3164	60	67

The second column gives particulars of a piston in a German made engine which has given reasonably good results. After about six months' running the pistons were found to be slightly deformed and showed signs of wear; but they would generally be classed as good. The piston in the German engine dealt with in the third column did not last six months, it was badly worn and star-cracked, but certainly not because the phosphorus was not low enough or the manganese not sufficiently high. The results derived from working the next engine described as "Continental" were bad from the first. The pistons were scrapped and new ones made from the same design. To prove the effects of phosphorus these were cast with this element as high as 1.34 per cent, but

with a silico-carbon ratio to satisfy the formula. The manganese was very low, 0.28 per cent. These pistons are still giving excellent results. The pistons of the type dealt with in the sixth column and described as "Scotch" have also given excellent results.

Manganese has a tendency to harden the metal both directly and by causing the carbon to remain in the combined form. The general properties of the metal, other than a tendency to chill, are not materially affected so long as the manganese is not in greater proportion than 0.7 per cent. If denseners are used on the face of the castings it is not advisable to have the managanese over 0.4 per cent.

The proportions of the various elements found to give good results for diesel engine pistons and liners are: Total carbon, 3 to 3.2 per cent; silicon, 1 to 1.20 per cent; phosphorus, not over 1 per cent; manganese, not over 0.50 per cent; sulphur, 0.12 per cent. For cylinder covers which do not require to be so hard and in which metal with less contraction is desired, the silicon can be increased to 1.50 per cent and the manganese to 1 per cent. The most advantageous amount of steel to be added to the metal is about 15 per cent.

Considering the enormous heat which the pistons and cylinder heads have to withstand it is imperative that everything in the nature of cooling strains in the castings should be eliminated. Heat treatment of cast iron at low temperatures affects the physical properties of the metal and a prolonged treatment at 780 Cent. is positively dangerous. The results of annealing on the physical properties of a few out of many test bars is shown in Table II.

The tensile test bars were cast 1½-inch diameter, turned down after annealing to ½-inch area in the center before testing. The transverse bars were cast 1½-inch square, machined to 1-inch square and tested on 12-inch centers. Deterioration of a serious nature, as shown in table III was caused by exposing them to the action of a coal fire flame. The alterations in the chemical composition of the same bars were: Total carbon reduced from 3.16 per cent to 3.02 per cent; sulphur increased from 0.112 per cent to 0.17 per cent; silicon decreased from 1.58 to 1.30 per cent.

For the guidance of founders, two useful workshop tests, with the class of iron suggested are: Impact test and casting temperature. The sections of diesel engine parts are very thick, particularly the piston heads and it is advisable to test the metal under nearly similar conditions.

A satisfactory test is on bars 40 millimeters square (1.57 inches) supported on knife edges 160 millimeters (6.3 inches) apart, and by dropping a weight of 12 kilometers (26.5 pounds) from a height of 30 centimeters (11.8 inches), increasing the height of drop by increments of 5 centimeters (1.9 inches), until the sample breaks, the height of drop at which the bar eventually fractures being taken as the impact figure. Attached to the weight, in such a manner as to strike the bar parallel to the supporting knife edges, and at the center, is another knife edge. The face of each knife edge should be rounded ⅛-inch radius for bearing surface. A result of 55 centimeters (21.5 inches) is considered none too high for this class of work, although this is quite a severe test.

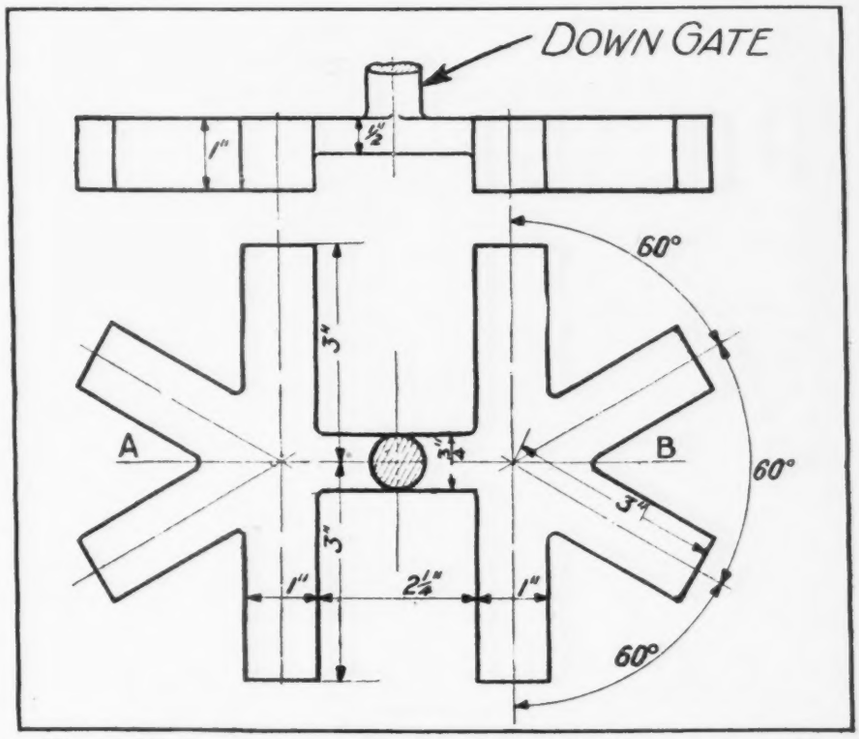


FIG. 7—SHOWING THE RESULT OF POURING THE SAME COMPOSITION OF IRON AT VARYING TEMPERATURES

Low silicon and low carbon cast iron are susceptible to the effects of casting temperature, and some irons employed for such purposes are also liable to liquid contraction. A handy workshop test for casting temperature with this class of iron, consists in making bars of the general dimensions shown in Fig. 6. When cold, the bars are broken through the line *A-B*, the condition of the fracture giving an indication of the temperature at which the metal was poured. Passing from the correct temperature (which is usually as hot as can be obtained from the cupola) to a low one, the following fractures will be observed. Perfectly solid and homogeneous; then slight whitish center; then brown centers of varying sizes and depth of color, as temperature is lowered, and then black center. With the latter are always associated open cavities, and immediately above each cavity is invariably found a gas hole. A set of results showing various casting temperatures is shown in Fig. 7.

TABLE III

Result of Exposure to Coal Fire Flame

Test No.		Tensile strength Pounds per square inch	Transverse strength Pounds, 1-inch square bar, 12-inch centers	Impact	Hardness
4	As cast	38,752	3892	75	82
	Annealed	34,697	3752	55	97
5	As cast	39,872	3584	70	78
	Annealed	32,256	3444	60	110

Anneal Malleable in Tunnel Kiln

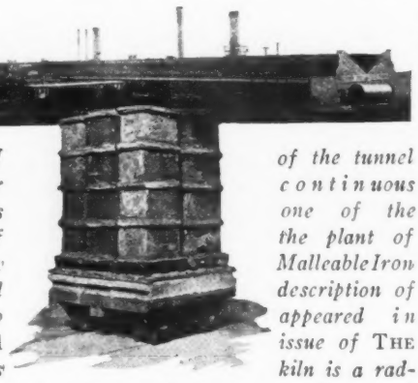
Castings Put in Pots Without Packing Material—Time from Entrance into Furnace to Exit is 120 Hours—Many Pyrometer Couples Determine Temperature Throughout the Furnace

BY H. E. DILLER

WHILE innovations are constantly being made in the metal casting industry, the great majority of them are so slight that the change brought about by their introduction is not generally noticed. Many minor developments in the course of time change the methods of production by easy stages, but there is an occasional radical departure from general practice which is marked.

Malleable castings have been annealed on the same general plan almost since the beginning of the industry. That is to say they have been packed in pots with an oxidizing scale and loaded into large ovens which are cooled each time to slightly above room temperature and again heated with the charge. Improvements have been made from time to time in the design of the ovens, in the method of packing the pots, in the apparatus employed for charging the pots, and in the method for firing. However, the general plan of packing the pots in a comparatively cool oven, heating the charge to the required temperature and cooling in the oven to well below the red heat after the castings have been soaked at the maximum temperature for a designated length of time, is practiced at practically all malleable foundries. This process leaves plenty of room for improvement. The length of time required is excessive, the weight to be handled is about doubled by the packing, and a large amount of heat is wasted by cooling and reheating the oven each cycle. Experiments have shown that an oxidizing packing is not as essential as had been thought and some foundries have adopted sand for packing, while a few have dispensed with all packing for some classes of castings. However, the length of a cycle, which is usually from 6 to 8 days has not been appreciably lessened although experimental tests have shown that it is possible to anneal a casting in 40 hours or less and get fair results.

Recently the tunnel kiln has been introduced for annealing malleable iron, one of these kilns having been installed at the plant of the Saginaw Malleable Iron Co., Saginaw, Mich. This kiln was installed by the American Dressler Tunnel Kilns, Inc., New York, under the direction of D. A. Drozeski, who furnished the heating curve for which the kiln was designed. While it is entirely new to the malleable iron industry, similar kilns long have been in use for firing porcelain and more recently for annealing steel. The main difference in the kilns used in the porcelain industry and in the one in service at the Saginaw foundry is the heavier charge which must be carried in the malleable foundry. Otherwise the requirements influencing the design of the kilns is quite similar.



A KILN of the tunnel type for continuous annealing is one of the features of the plant of the Saginaw Malleable Iron Co., a general description of which appeared in shop issue of THE FOUNDRY. *This kiln is a radical departure in the method of annealing and while its full advantages have not yet been determined, it has been in operation long enough to show certain tendencies and indicate what advantages may be expected from its operation. The construction and operation of the kiln are described in this article from information supplied by the Saginaw company. An article on the method of time study used by this company will appear in a later issue.*

In the operation of the kiln, castings are packed into pots without packing material. The pots are placed on cars which are charged into the furnace through an antechamber at regular intervals. The cars travel through the kiln in an opposite direction from that in which the gases of combustion are moving, although these gases do not come in direct contact with the cars or their charge. The cars continue on through the firing zone where they attain the maximum temperature. They then pass to a portion of the kiln which is not heated except as to the walls and roof absorb heat from the hot pots. While passing through this zone the charge is gradually cooled. When the furnace is filled, a car passes out the rear and every time a new one is charged into the kiln. This outgoing car first enters an antechamber from which it is drawn after the door between the antechamber and the main portion of the kiln is closed to prevent the admission of air into the kiln. The charge comes from the kiln too hot to be handled, so it is placed under a pipe through which air is blown on the hot charge until the next car comes from the oven. After the charge is cool enough to handle, the pots are dumped. A description of the construction of the kiln will aid in understanding the detailed process of annealing. A plan of the kiln is shown at the top in Fig. 1. This indicates the location of the burners on one side of the furnace. A duplicate set of burners is placed directly opposite to those marked. The cars enter at the left and travel in the direction indicated by the arrow. A cross section of the furnace is shown in the lower left-hand corner of Fig. 1. The combustion chambers *A*, *A*, are formed by hollow refractory tile placed against each other, make a duct through which the burned gases are carried to the exhaust. As the ducts are hollow with openings at both the lower and upper inside portions the gases of the kiln chamber enter the lower portion of the hollow tile, are heated by contact with the walls and so rise through both the front and back leg of the tile, passing out through the apertures at the top. This action produces a constant circulation of heated gas in the kiln so that the temperature is practically the

same at the top as at the bottom of the kiln. The proper mixtures of refractories for the tile at the different portions of the kiln have been determined by the Dressler company through many years of experience with porcelain burning kilns. Carborundum has been adopted for the tile at the hottest portion of the kiln. A layer of powdered silicious material is placed over the top of the furnace to conserve the heat.

The one end of the combustion chamber is at the exhaust and the other end, which is closed, is at the end of the firing zone fartherest removed from the entrance of the kiln. Next to the combustion chamber there is a similar chamber which extends to the exit end of the kiln. This chamber acts oppositely from the combustion chamber, being adapted for carying off the heat and thus cooling the pots more rapidly than they otherwise would be cooled. A pair of fans is provided on both sides near the exit end of the kiln, for drawing cool air through these ducts. However, so far the pots have cooled rapidly enough without the aid of the fans. Only one of each pair of fans would be required at a time to draw air through these ducts but like all electrical equipment on the kiln a duplicate set is provided as insurance against accident or breakage.

A pair of fans also is used on each side of the kiln and at each end to draw air through pipes located in close proximity to the wheels of the cars which pass through the kiln. These pipes extend from both ends on each side to the middle of the kiln. They serve to prevent the temperature of the wheels from going above 700 degrees Fahr. Two fans draw the exhaust gases from the kiln through preheaters used to give the air blast an initial heat before it enters the combustion chamber. Another pair of fans blows the air for combustion through the burners. The kiln has 14 burners, 7 on each side. These burners vaporize oil which is taken to the burners under 12 pounds pressure, but drips from the oil pipe and is blown by air at a pressure of ¾ pound. A carbon dioxide recorder made by the Foxboro Co., Foxboro, Mass., is used to determine whether the mixture of oil and air is correct to give complete combustion without an excess of air.

The temperature of the oven is watched carefully by the aid of 44 pyrometer couples located at different parts of the furnace. These are connected to an indicating instrument by four selective switches. Readings are taken every hour and marked on cards. The readings from each couple are placed on a separate card. Fig. 11 shows a portion of the cards on the rack to the right, while the indicating instrument is illustrated to the left above the four selective switches. Air volume and pressure gages may be seen towards the center of the illustration. The pyrometer equipment was installed by the Brown Instrument Co., Philadelphia. Calibration of the instrument and couple is made regularly to insure correct readings.

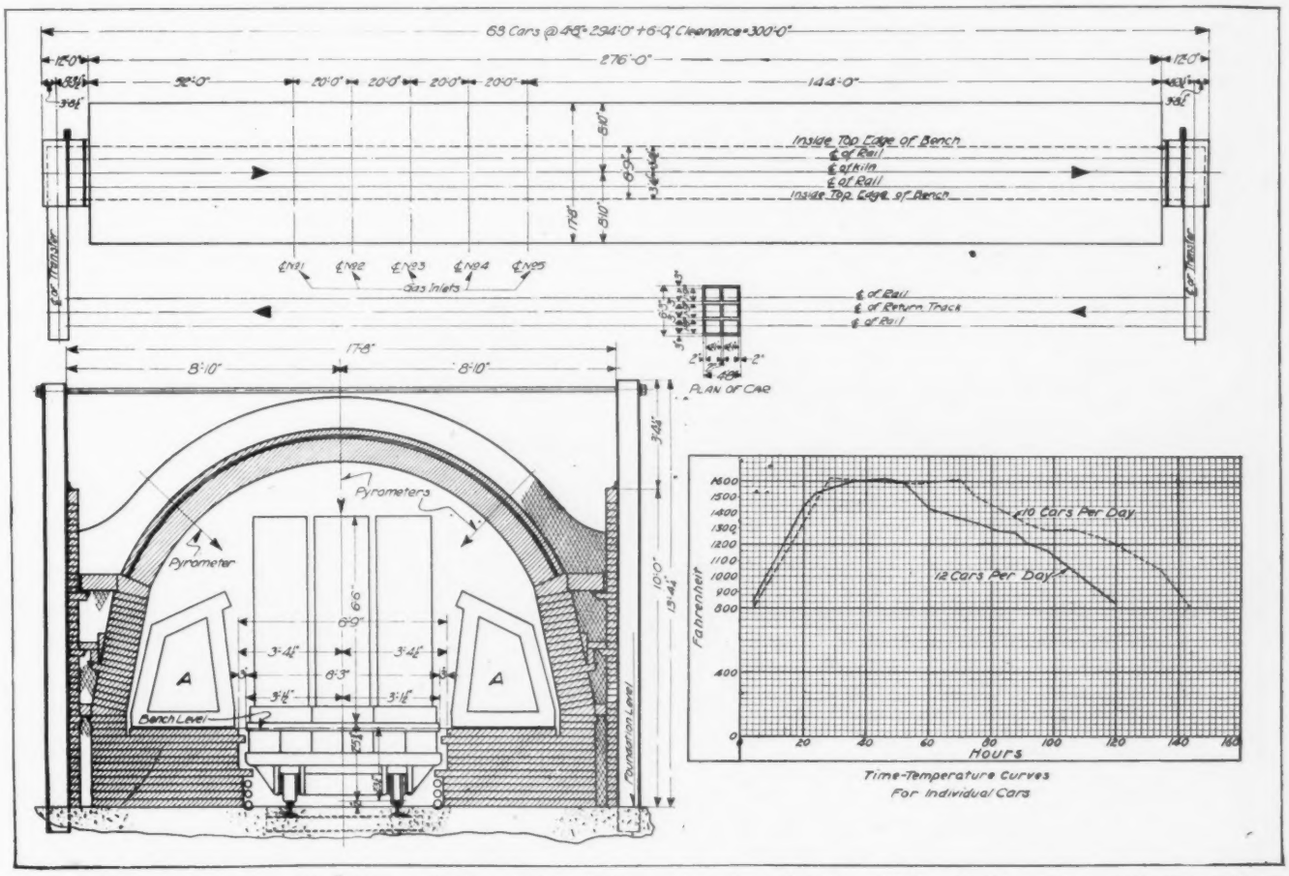


FIG. 1—ABOVE THE PLAN OF A CONTINUOUS ANNEALING TUNNEL KILN—TO THE LEFT, BELOW, A CROSS SECTION OF THE KILN—THE CHAMBER IS HEATED BY TE BURNING GASES WHICH PASS THROUGH THE FLUES *AA*—TIME TEMPERATURE CURVES ARE SHOWN BELOW, TO THE RIGHT—THESE CURVES VARY ACCORDING TO THE RATE AT WHICH THE CARS ARE CHARGED INTO THE KILN

The operation of the kiln may best be understood by the help of illustrations. Fig. 3 illustrates the loading of the pots. Wooden trays are placed on a gravity roller conveyor, a base made of white iron is then put on the tray and a pot is set on this. Following, a white-iron plate is used for three pots instead of the bottom stand casting. This makes a complete stack. The base supports have short feet as may be noted in the one to the right of the center column, Fig. 3, while the plates are flat and serve to prevent the weight of castings in the

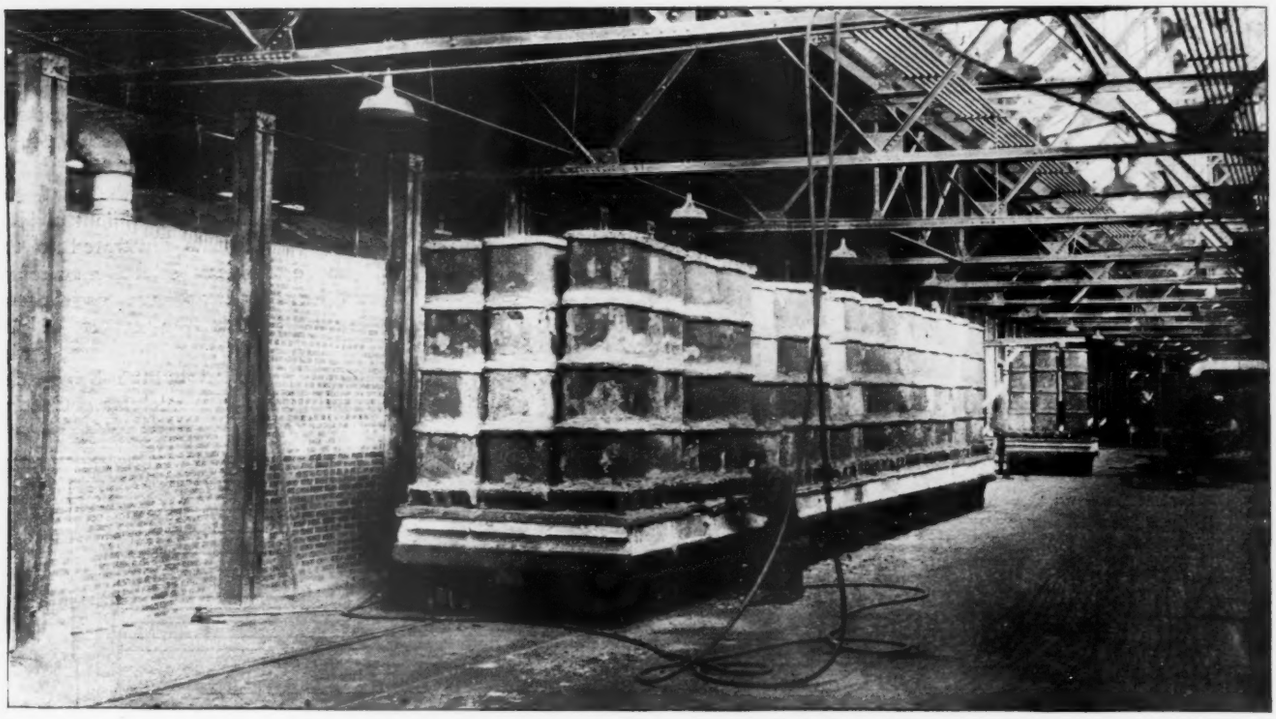


FIG. 2—BEFORE THE CARS ARE PLACED IN THE KILN CARE IS TAKEN TO SEE THAT NO PART OF THE CAR OR OF THE CHARGE WILL STRIKE THE SIDES OR ROOF OF THE FURNACE—THE CAST-IRON BOTTOM PLATE WHICH WAS EXPANDED BY THE TEMPERATURE IS BEING REPLACED BY STEEL

pot from bearing on those in the pot beneath.

No packing is used, the castings being put into each pot loose. One of the functions of packing material is to prevent warping, and it has been found that a few designs of castings have a tendency to warp when annealed without packing material. Some such castings were annealed in the ovens of the standard type. Later experiments showed that all castings could be annealed in the continuous kiln. The old ovens serve to anneal the over supply of castings on peak loads and can be discontinued when the foundry is not producing to its maximum capacity.

FIG. 3—SOME CASTINGS ARE PACKED INTO THE ANNEALING POTS BY HAND, WHILE OTHERS ARE SHOVELED INTO THE POTS AS THEY PASS ALONG A GRAVITY ROLLER CONVEYOR—THE ABSENCE OF PACKING MATERIAL LIGHTENS THE CHARGE TO BE CARRIED THROUGH THE KILN

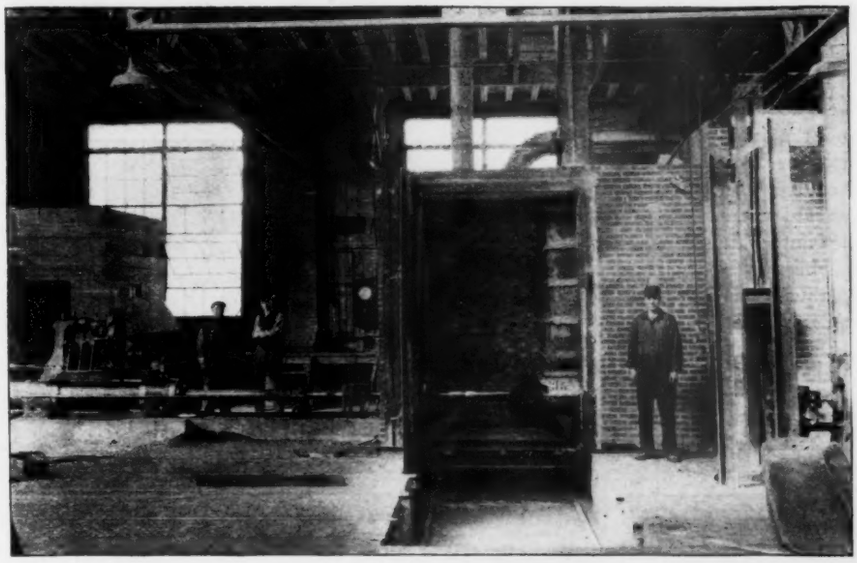


FIG. 4—CARS ENTER AN ANTECHAMBER AND ARE PUSHED FROM HERE INTO THE KILN BY AN HYDRAULIC RAM

Castings from some patterns which tend to warp are packed in the pots by hand. The two workmen to the right in Fig. 3 are engaged in packing castings by hand. The pile of castings shown towards the left of the same illustration are shoveled into the pots and the top of each pot is filled with the smallest sized castings which fill in the spaces between the larger castings.

Pots Loaded by Crane

After the pots are filled and covered they are loaded on a car by a crane and stacked four high. This operation is illustrated in Fig. 7, which shows the last pot being carried to a car. Another pot may be seen at the end of the gravity conveyor. The small castings which are nearby have not yet been shoveled into this pot. The joints between the pots are luted with a mixure of fireclay and sand before the car is placed in the oven. The pipe swung horizontally to the left of the illustration is used for measuring the height of the stacks on the car to prevent any car from being loaded so that it will become jammed against the roof of the furnace. Another height gage is located at the end of the track leading to the entrance of the kiln. The pots are 16 x 25 inches inside and are 16 inches high. The stacks are placed on the car three abreast and two rows deep. A number of loaded cars ready to be charged in the kiln are shown in Fig. 2. The workman is chipping the sides of the cast-iron

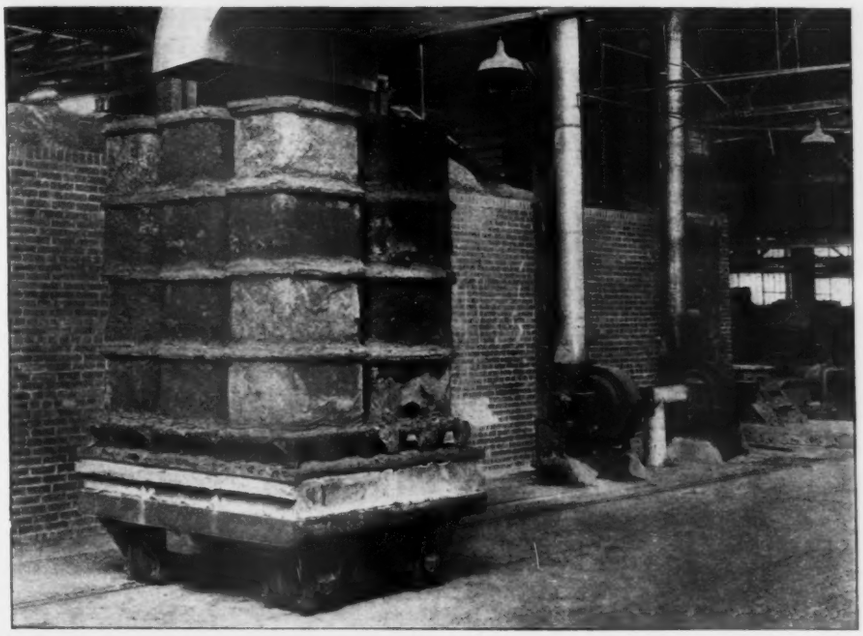


FIG. 6—AIR IS SOMETIMES BLOWN OVER POTS AFTER THEY COME FROM THE FURNACE

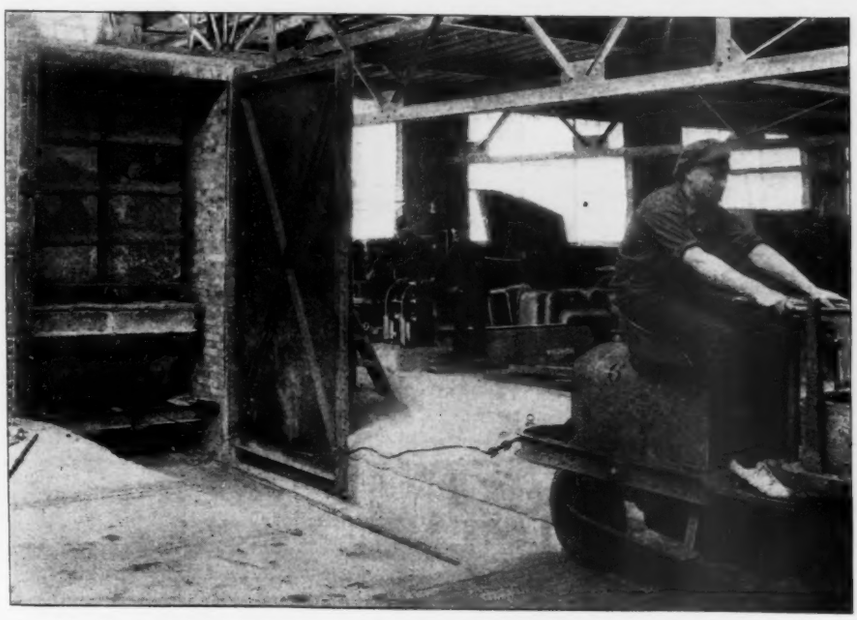


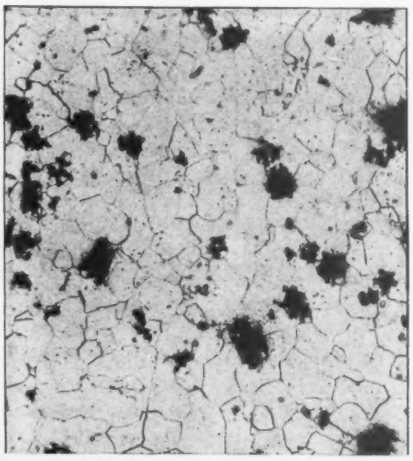
FIG. 5—A TRACTOR PULLS THE CARS FROM THE ANTECHAMBER

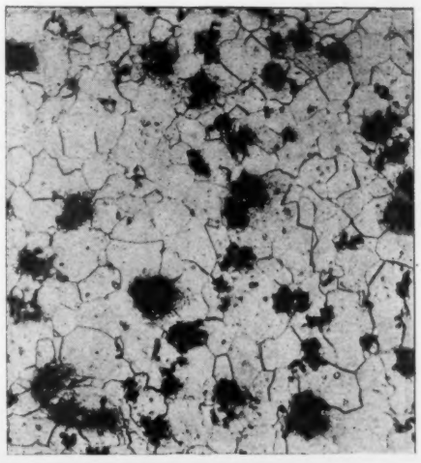
plates which cover the car. These plates are enlarged by the heat of the kiln and care must be taken to determine before they are put in the kiln that they are not too wide, otherwise the car would stick while being passed through the kiln. On account of this tendency of cast iron to grow under change of temperature the bottom plates will in the future be made of cast steel or a special grade of cast iron.

Huge Weight Transferred

When the weight of one of these loaded cars is considered the enormous weight which must be pushed through the kiln by the hydraulic ram will be appreciated. The car weighs approximately 3 tons and the pots and bases on each car about 7 tons, while the castings are calculated to

weigh 5 tons, making a total weight of 15 tons for each loaded car. Thus the 60 cars which compose the full charge total 900 tons which must be moved through the oven at each admission of a new car into the oven.





FIGS. 9 AND 10—MICROGRAPHS OF THE CENTER OF SAMPLES ANNEALED IN THE TUNNEL KILN—THESE INDICATE THE STRUCTURE OF NORMAL MALLEABLE —NOTE THE TEMPER CARBON SURROUNDED BY FERRIETE

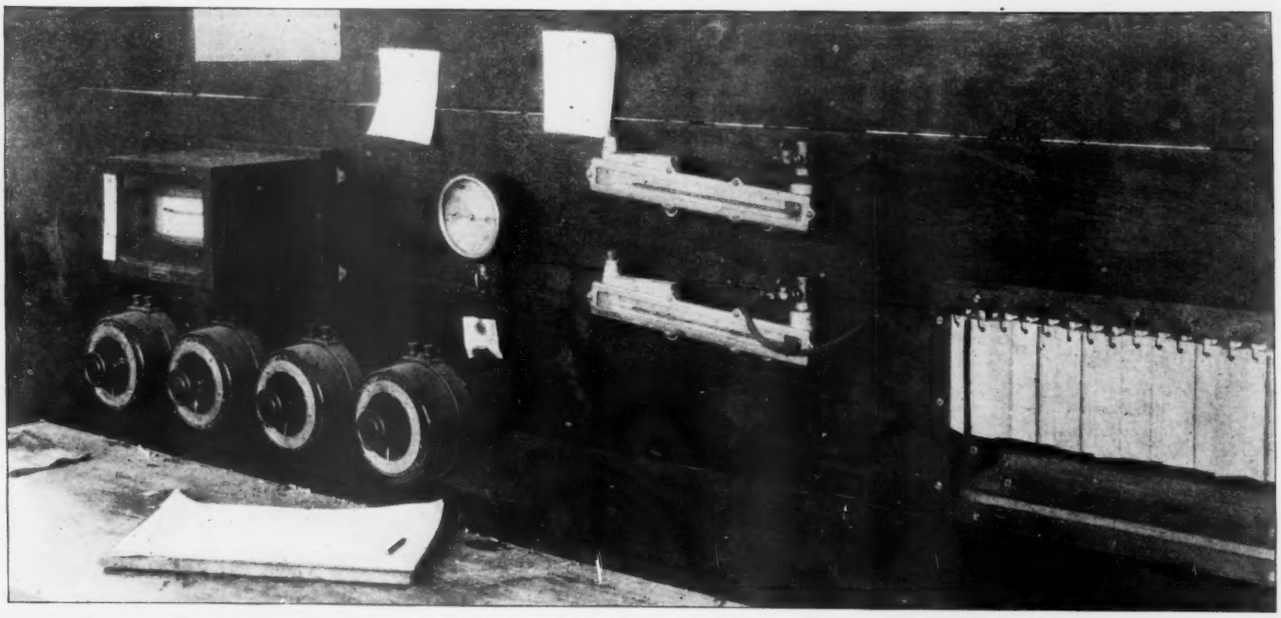
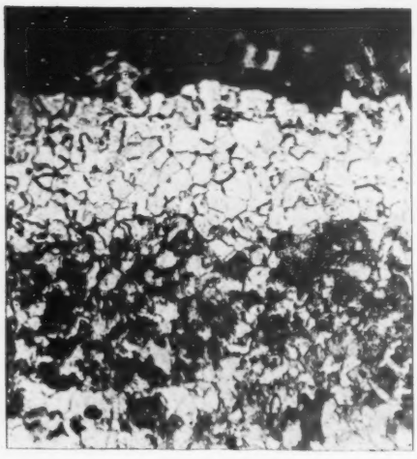
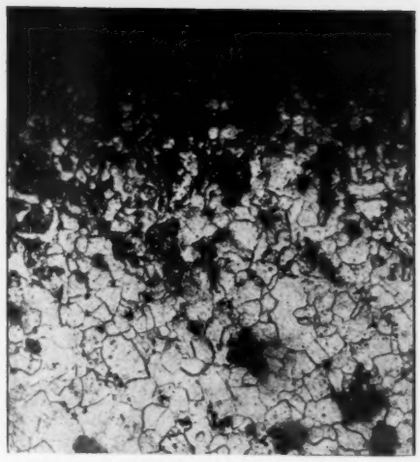


FIG. 11—TEMPERATURE READINGS ARE MADE THROUGH A MULTIPLE CONTACT SWITCH FIGS. 12 AND 13—MICROGRAPHS TAKEN FROM THE EDGE OF CASTINGS, SHOWING A SLIGHT OXIDATION AS INDICATED AT THE TOP OF THE ILLUSTRATIONS





Cars are run into the antechamber of the kiln on a transfer car and from this car they are pushed into the kiln by an hydraulic ram. This ram may be noted in Fig. 4 which shows a car partly pushed into the kiln. The door into the antechamber was left open to allow the photograph to be taken. In actual work, the door between the antechamber and the kiln is closed before the door into the foundry is opened. The car then is placed in the antechamber and the outer door is closed. The air in the antechamber is then washed out by blowing exhaust gases from the combustion chamber through the hole shown in the bottom and out through the stack in the roof. After the air is all out of the antechamber the door into the kiln is opened and the car is pushed in by the hydraulic ram. The door into the kiln is then closed and the antechamber is ready to receive another car. The door is operated by a large hand wheel. One of these wheels may be seen on top of the furnace in Fig. 5 which is a view of the exit end. This illustration shows a car being pulled from the antechamber by a tractor to which it is attached by a wire rope. The last car in the kiln is pulled into the antechamber by a windlass operated by two workmen. This windlass may be seen between the two men standing in the center of Fig. 5. The empty space left by this car allows a car to be shoved in at the other end of the kiln without opening the door between the kiln and the exit antechamber.

The tractor is weighted with pig iron to give it traction enough to pull the car. The front end of the tractor is fitted with a bumper so that it may push the annealing car off the transfer car and deliver it to the unloading floor to which it is pushed on a track. However, before it is un-

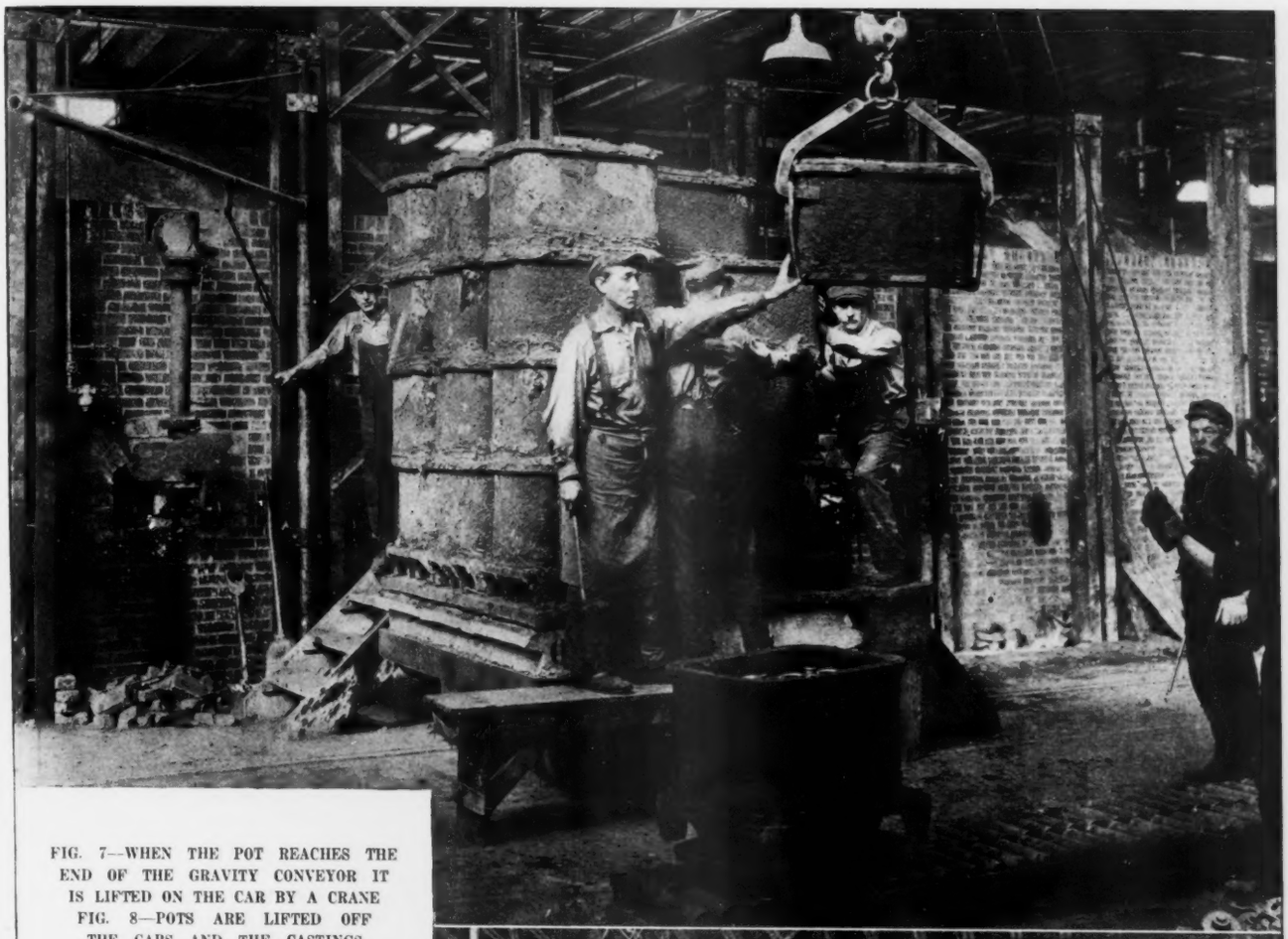
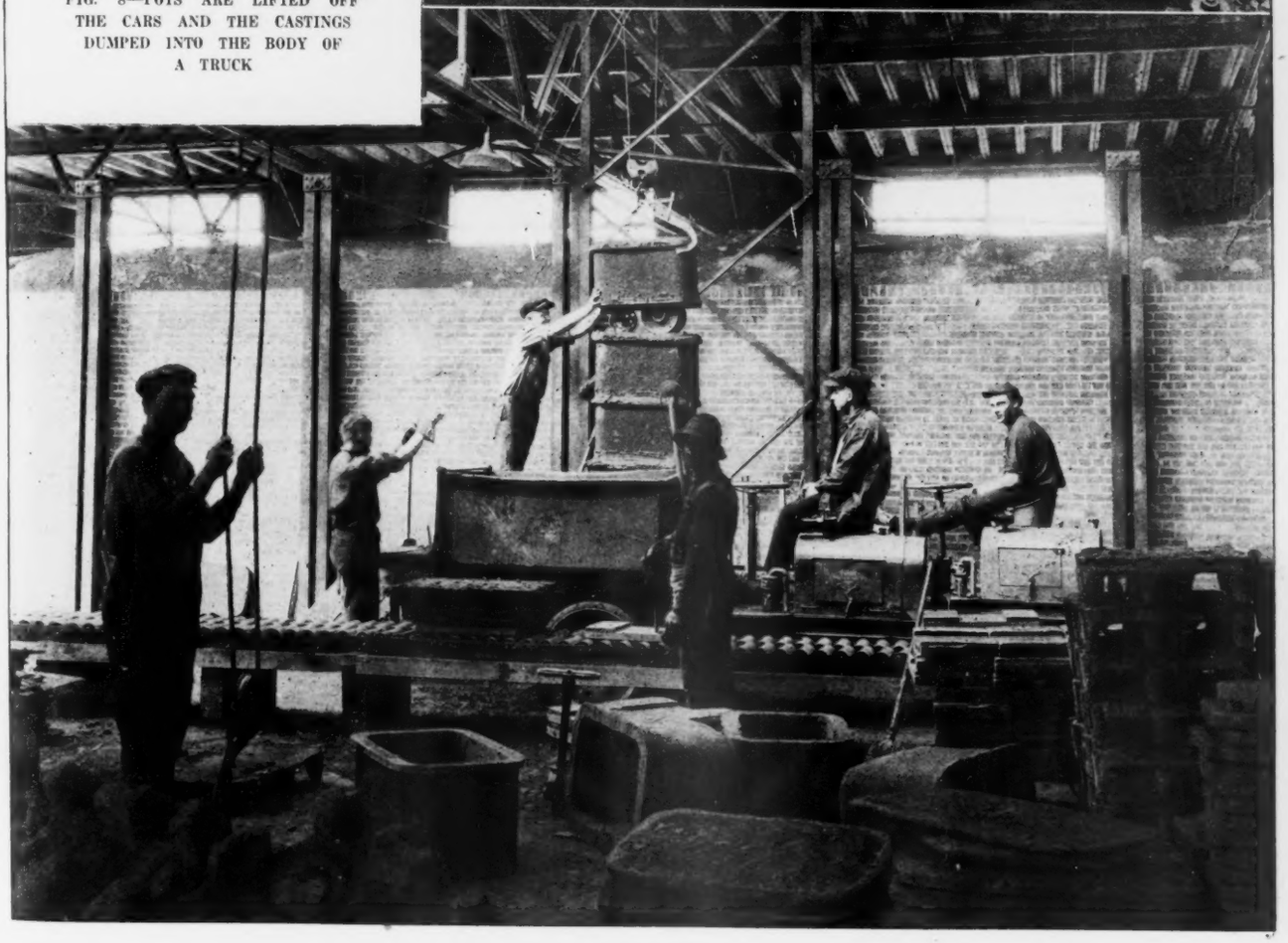


FIG. 7—WHEN THE POT REACHES THE END OF THE GRAVITY CONVEYOR IT IS LIFTED ON THE CAR BY A CRANE
FIG. 8—POTS ARE LIFTED OFF THE CARS AND THE CASTINGS DUMPED INTO THE BODY OF A TRUCK



loaded it is allowed to stand on the cooling floor for 12 hours. A portion of this time it is directly under a pipe through which cooling air is blown on the pots. Fig. 8 shows a stack of pots being unloaded. The crane picks up one pot at a time and carries it over the body of a tractor, when the castings are shaken out. The tractor then takes the castings to the cleaning and sorting room and the bases and plates are set on the gravity conveyor and carried to the loading section. Being annealed without packing, there is only a small amount of cleaning necessary on a few of the castings which were not thoroughly cleaned of sand in the hard cleaning room. Many castings are sent to the customer as they come from the annealing kiln.

The temperature through the kiln is controlled in a measure by the rate at which cars are put through. It has been found practical to charge the kiln at the rate of either 10 or 12 cars a day. Charging 12 cars a day a car goes through the furnace in 120 hours or 5 days, while when the rate is 10 cars a day 6 days are required to complete the cycle. The kiln is operated seven days a week while the foundry is only producing castings on six days. The loaders and unloaders operate only six days a week but an excess of cars are loaded each day so that there is a supply for the time the foundry is closed and the kiln is operated. Then, during Sunday, a number of loaded cars from the kiln are accumulated. To care for this contingency an excess of 23 cars are kept on hand. The output of the kiln may be regulated to a degree by changing the rate at which the cars are charged into the furnace. Indications are that this rate only may be varied from 10 cars a day to 12 cars a day but a much wider variation may be found to be practical.

The temperature through the furnace is shown by the chart in the lower right hand corner, Fig. 1. This curve shows the temperature of the portions of the furnace occupied by a car at different times as it traveled through the kiln. The chart indicates that the temperature of the gases in the furnace as they were passing out was approximately 800 degrees Fahr. From this temperature the furnace is gradually heated up until it reaches 1600 degrees Fahr. The cooling end of the furnace was about 800 degrees Fahr. In these two cycles, the pots which were charged into the furnace at the rate of 10 cars per day cooled to the same temperature as those charged at the rate of 12 cars per day, but they were held at the maximum temperature for a slightly longer time. The chart shows the discharge gases to be reduced to 800 degrees Fahr., the excess heat being absorbed by the cold pots entering the kiln. Should experiments indicate the advisability of cooling the pots quicker, this could be done by drawing cool air through the cooling chambers at the end of the kiln, as previously mentioned. Thorough tests were made of the metal in five different heats to determine the effect of the anneal. These tests were carried out by Prof. A. E. White, University of Michigan. Results of these tests which showed a minimum tensile strength of 49,300 pounds per square inch, and a minimum elongation of 10.5 per cent in 2 inches are given in the accompanying table. The analyses of all five samples show them to have the normal composition of the iron produced at the Saginaw foundry. Micrographs were made to show the structure of the metal. Figs. 9 and 10, illustrating the characteristic structure of malleable iron composed of temper carbon and ferrite, are representative of the centers of all five samples. Figs. 12 and 13 show the structure of the edge of different samples. One sample, Fig. 12 shows at the edge a ferrite rim inside of which is a ring of pearlite and ferrite, and next to this is normal malleable consisting of temper carbon and ferrite. Fig. 13 illustrates the structure at the edge of another sample. The skin, indicated next to the black portion of the cut consists of a mixture of ferrite and pearlite, while the portion behind this is made up of the normal structure of malleable iron. None of the rings in these two figures averages more than 0.005 inch in thickness. These micrographs indicate that the skin of the castings was slightly oxidized. To overcome this, it was decided to lute the joints between the pots and the covers, with mixture of clay and sand. This prevents the slight oxidation of the skin which otherwise would take place during the anneal.

The Saginaw company states that the first cost of this kiln is somewhat higher than the cost of the number of periodic furnaces which would be required to anneal the amount of castings annealed by the tunnel kiln. The length of time the kiln has been in operation is too short to determine the amount of saving in labor this method of annealing will effect over the periodic method. As at present operated three packers are required, three men load the stacks on cars, one man lutes the pots and four laborers unload the annealed castings and place the empty pots, bases, plates and base boards on the conveyor. These men work one shift six days a week, but the six heaters work in two shifts seven days a week three on a shift. The heaters put the cars in and out of the kiln and one of them takes hourly temperature readings of the pyrometer couples. Besides this gang, part time of two truckers is required to carry the castings to and from the kiln and to move the cars. A kiln foreman has direct charge of the operation of the kiln but does not supervise loading or unloading the cars, which duty is relegated to the labor foreman. When operating full with no delays, approximately 60 tons of castings are annealed each of the seven days in a week.

The advantages which the Saginaw company find in the tunnel kiln are a shorter annealing time which is cut from an 8-day cycle to a 5-day cycle, and a more uniform product. This latter is said to be marked. Then, too, owing to not using any packing material it is unnecessary to clean 80 per cent of the castings, but this percentage can be shipped to the customer as they come from the kiln. The ability to anneal without packing is attributed to the almost neutral atmosphere in which the pots are kept during the anneal. This is accomplished because the kiln is almost a complete muffle with air excluded.

Composition and Properties of the Annealed Iron

	Heat Analysis				Test Bar Analysis	
Sample No.	Carbon	Manganese	Phosphorus	Sulphur	Silicon	Carbon	Silicon
1	2.55	0.25			0.85	2.10	0.83
2	2.55	0.20			0.95	2.25	0.95
3	2.55	0.28	0.164	.051	0.85	2.05	0.80
4	2.00	0.31			0.95	2.20	0.95
5	2.50	0.25	0.160	.052	0.95	2.15	0.88

Physical Properties Sample No.	Ultimate Tensile Strength	Per cent Elongation in 2"
1	51,500 lbs. per sq. in.	14.80
2	49,300 lbs. per sq. in.	10.90
3	53,000 lbs. per sq. in.	14.80
4	50,400 lbs. per sq. in.	10.50
5	49,400 lbs. per sq. in.	10.50

FORMULAS FOR THE BRASS FOUNDRYMAN

DATA ON ALUMINUM BRONZE

Adding Manganese to Aluminum Bronze

The effect of adding manganese to aluminum bronze is shown by test. The alloy tested had following composition:

	Per Cent
Copper	89.00
Aluminum	10.00
30% Manganese copper	1.00

The alloy was cast into sand molds containing imprints of the standard nonferrous test bars, which were cast to size having 2-inch risers on either end of the grips as is usual in the case of aluminum bronze. The physical properties, on an average of three test bars were as follows:

Tensile strength, pounds per square inch	63,800
Elastic limit, pounds per square inch	19,700
Elongation, per cent in 2 inches	49.3
Reduction of area, per cent	42.1

Calcium-Aluminum Bronze

The effect of calcium on aluminum bronze is illustrated by test. The alloy tested had the following composition:

	Per Cent
Copper	89.00
Aluminum	10.00
10% Calcium-copper	1.00

The alloy was cast into sand molds and the bars were cast to size. The average physical properties of three bars were as follows:

Tensile strength, pounds per square inch	54,000
Elastic limit, pounds per square inch	19,700
Elongation, per cent in 2 inches	22.5
Reduction of area, per cent	30.4

Iron in Aluminum Bronze

An alloy was cast into test bars attached to a keel block in the manner usual with manganese bronze. The following alloy was tested:

	Per Cent
Copper	89.00
Aluminum	10.00
Iron	1.00

The bars were cut from the block and machined to standard size. The following results were obtained:

Tensile strength, pounds per square inch	69,600	73,100
Yield point, pounds per square inch	20,400	23,000
Elongation, per cent in 2 inches	19.5	22.5
Reduction of area, per cent	23.0	21.6

FORMULAS FOR THE BRASS FOUNDRYMAN

DATA ON ALUMINUM BRONZE

Iron in Aluminum Bronze

Tests of an alloy of aluminum, 10 per cent; iron, 1 per cent; and copper, 89 per cent, with cast to size test bars were made. Risers 2 inches diameter were placed on either end of the grips. The bars were made with long grips. Four bars were cast and tested as follows:

	Bar, 1.	Bar, 2.	Bar, 3.	Bar, 4.
Elastic limit	18,600	18,300	26,500	22,600
Ultimate strength	76,600	77,100	74,200	75,600
Elongation	26.0	27.5	23.0	27.0
Reduction of area	24.8	29.8	27.5	29.9

The elastic limit and ultimate strength are given in pounds per square inch, the reduction of area in percentages, and the elongation as percentage of stretch in 2 inches.

Phosphorus in Aluminum Bronze

Alloy used as control:

	Per Cent
Copper	89.00
Aluminum	10.00
Iron	1.00

Alloy with phosphorus:

	Per Cent
Copper	88.90
Aluminum	10.00
Iron	1.00
Phosphorus	0.10

Results of physical tests were as follows:

	Control bar	Treated bar
Yield point, pounds per square inch	26,100	27,700
Ultimate strength, per square inch	76,400	70,000
Elongation, 2 inches, per cent	21.0	12.5
Reduction of area, per cent	17.6	17.5

Silicon Aluminum Bronze

The effect of silicon is illustrated by the following tests. The alloy consisted of the following proportions:

	Per Cent
Copper	89.50
Aluminum	10.00
Silicon	0.50

Result of physical tests were as follows:

Yield point, pounds per square inch	28,800
Ultimate strength, pounds per square inch	77,000
Elongation in 2 inches, per cent	1.5
Reduction of area, per cent	1.4

THE FOUNDRY DATA SHEET, AUGUST 15, 1920
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

How Spur Gear Patterns Are Made—I

Approved Methods for Laying Out the Material and Afterward Joining It Together to Facilitate Molding and Prevent Distortion of the Patterns While They Are in Use

BY JOSEPH HORNER

ALTHOUGH many more gears are cut now than formerly, enormous quantities are still molded from patterns for machinery in which the fine degree of accuracy required for machine tools, electric cranes, automobiles, and so on is not essential. For all ordinary purposes, the cost of cut gears is prohibitive, and besides they are not necessary.

A higher standard of excellence is demanded and obtained in wood patterns than formerly. Sometimes teeth are shaped with fly cutters, and molded on machines. They are drawn through stripping plates and the castings come out without taper on the teeth, Wheel-molding machines using a segmental tooth block, and a dividing arrangement for pitching, also produce very accurate castings. Wheels are produced by either method as good for service as indifferently cut gears. It is also well to remember that the hard skin on cast teeth is favorable to their durability,

Spur gear patterns include a large number of different types, ranging from small pinions without arms; to large wheels having arms; the number, and shapes of which vary both according to design and with the sizes of wheels.

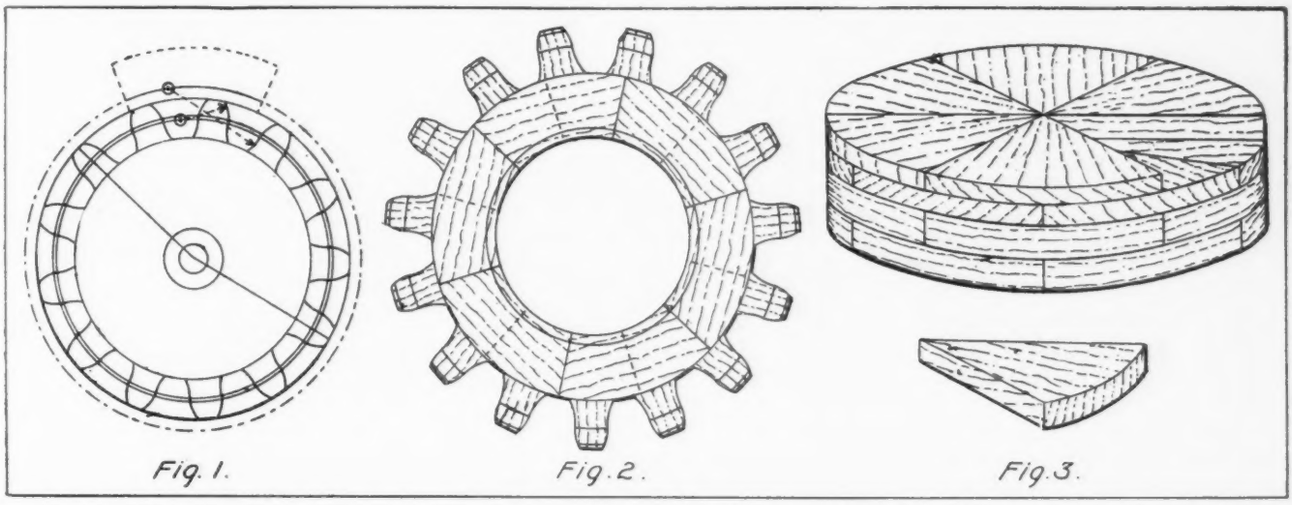


FIG. 1—SMALL PINIONS ARE CUT OUT OF THE SOLID FIG. 2—ONE METHOD OF BUILDING UP A LARGER SIZE FIG. 3—ALTERNATIVE METHOD TO THAT SHOWN IN FIG. 2

Fig. 1 illustrates a small, solid pinion pattern at a definite stage of its construction; Fig. 2 shows one method of building-up a larger pattern. The alternative to Fig. 2 is to use segments, strictly, sectors, extending to the center, the building-up of which is shown in Fig. 3, with the grain disposed radially, so that no unequal diametral shrinkage is liable to occur. In Fig. 2 it is arranged tangentially, in which case the pattern may conceivably shrink in its diameter, and would do so if the diameter were large, and the segments wide. The grain is tangential in Fig. 2, but the sweeps are both narrow and short, so that no perceptible diametral shrinkage can occur. Fig. 2 is preferable to Fig. 3 when pinion patterns exceed 7 or 8 inches in diameter, and this arrangement of sweeps is adopted in all gears up to the largest, but the number of sweeps is, of course, increased with diameters. The thickness of segments should not exceed about ½-inch in the smaller gears, and ¾ or ⅞-inch in the largest. With increase in number, the risk of distortion consequent on shrinkage is lessened. A large number of sweeps is mutually coercive, and binding. With small numbers of thick pieces, local shrinkage and distortion will occur in course of service.

Except for some very small pinions, measuring, say not more than 5 or 6 inches across, no pattern gears are cut in solid stuff. When below those diameters, they can be so cut, using a block of thoroughly seasoned pine, or mahogany, with the grain running longitudinally, that is, in the direction of the teeth. Anything larger must be built-up to prevent shrinkage or swelling of the grain from interfering with the shape and dimensions of the pattern. In no case should segmental pieces be prepared very thick or very long, since that would in a measure defeat the object desired. Several examples of good practice are shown in the accompanying illustrations.

Sweeped-work is built up in different ways. The sweeps are sawn from board with the band saw, using a templet sweep

pitched mechanically; but apart from this practice which only covers a small proportion of the pattern gears made, the industry generally has been raised to a higher plane. Firms who have had little or no experience in the construction of gears should place them with those who make pattern gears a specialty. Those who construct their own patterns regularly understand how to secure permanence of form, and to proportion and shape teeth to meet present-day requirements. Development in the practice of cutting teeth has had an influence in improving pattern gear standards. If this were not so, more cut gears would be employed than at present. The practice of machine-molding also has had influence on gear pattern making Gears of fairly large dimensions are

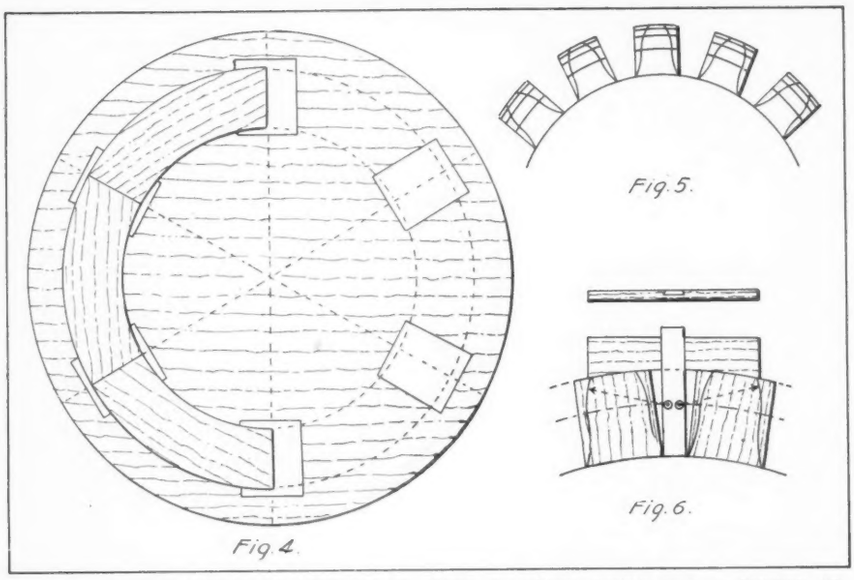


FIG. 4—THE FIRST COURSE OF SEGMENTS IS GLUED ON PAPER STRIPS FIG. 5—METHOD OF FITTING AND LAYING OUT THE ROUGH TOOTH BLOCKS FIG. 6—TEMPLET ON WHICH TO LOCATE CURVE CENTERS

to mark them from. They are marked adjacent as closely as possible, to economize on lumber. Where a pony planer is available, it is good practice to bring the boards to the same thickness before sawing. They will be all of equal thickness, and the entire wheel can be built up before placing it in the lathe. Some slight correction with the trying plane will suffice on each course. The first course of sweeps is glued on paper strips shown in Fig. 4. When the glue has dried, the paper holds the entire job on the face plate. For added security, a screw may be put into each sweep from behind the plate, but only as a stand-by in the heavier patterns. It is not necessary to use anything but glue to secure the courses of segments to each other; but in order to avoid the delay while the glue is drying, it is usual either to drive wooden pegs, or wire nails in each course.

In all cases, with the single exception of very small pinions, typified in Fig. 1, the wheel body, or wheel rim is prepared independently of the teeth. These are attached to the rim after it has been turned. In Fig. 1, the teeth are cut in the solid wood. Wheel rims are turned either parallel, or preferably with a slight taper, and the teeth prepared separately, or the blocks from which they are to be cut when in place, are then attached. The amount of taper given is only that which would be indicated by a tight and an easy fit of the calipers on top and bottom; or by the contact of a set-square at the top, and just seeing the light through at the bottom. In small patterns, it can be measured with calipers; in large wheels a straightedge is laid across the front face, and a set-square is used against it.

Many different methods are adopted in fitting and cutting the teeth. The choice depends chiefly on the degree of accuracy and permanence of form desired in the pattern. Teeth are cut solidly with the body in small pionions. They are glued on the body and there worked from cubical blocks with chisels, gouges, and planes. They are worked with fly cutters, and pitched mechanically. They are worked away from the rim, and glued on afterwards. They are attached to the rim with dovetails, and afterward worked away from the rim with planes, and returned to their correct positions by the dovetail fittings.

Fig. 1 illustrates the cutting of teeth on the body block—the grain running axially. The block is turned to the outside diameter of the teeth, and the teeth pitched and marked out according to the standard system. This is done first on one face, and then one or two tooth centers are drawn across, carried over perpendicularly, and the teeth marked similarly on the other face. Concentric circles are struck on which the centers of the tooth curves are set. They may both fall within the diameter of the block, or one for the roots will come without in small pinions. A templet, shown dotted, is then used to set the compass point on. After having been marked, wedge-shaped pieces are sawn out between the teeth, leaving them to be worked with the hand tools or with a fly cutter.

Teeth are worked in place with chisels, gouges and planes, not only when small pinions are cut in solid stuff, but also in large gears. The blocks for the teeth are glued on the rim with allowance for turning the tops and the ends. When they have been turned, the pitch lines, and lines of centers are struck on one face, the centers pitched and squared over as in Fig. 1, and the teeth marked on both faces. Though this may seem an undesirable method, using gouge, chisel and plane, it is accurate in the hands of an experienced man. A thin straightedge, narrow enough to go between the teeth is used, its edge being rubbed with chalk or with red lead to check the work of the gouge and chisel, since a rebate plane can only be used for the upper portions of the tooth faces. The teeth are sandpapered carefully, using a rubber planed on one side to the concave curvature of the tooth flanks, of cycloidal design, and flat on the other side for the convex curves. The advantage of the method is, that the teeth are permanently fixed when glued, and being afterward nailed, they cannot readily be shifted.

The rough blocks are fitted either as in Fig. 5 or Fig. 7, the latter, showing filling-in pieces to afford support to the blocks while they are being turned. The pieces are not necessary if the turning of the tooth ends is done carefully, with light cuts, especially if the leaving sides of the teeth are chamfered with a chisel before commencing.

Teeth are worked separately and set on the rim by center lines. They can be shaped accurately and more readidly

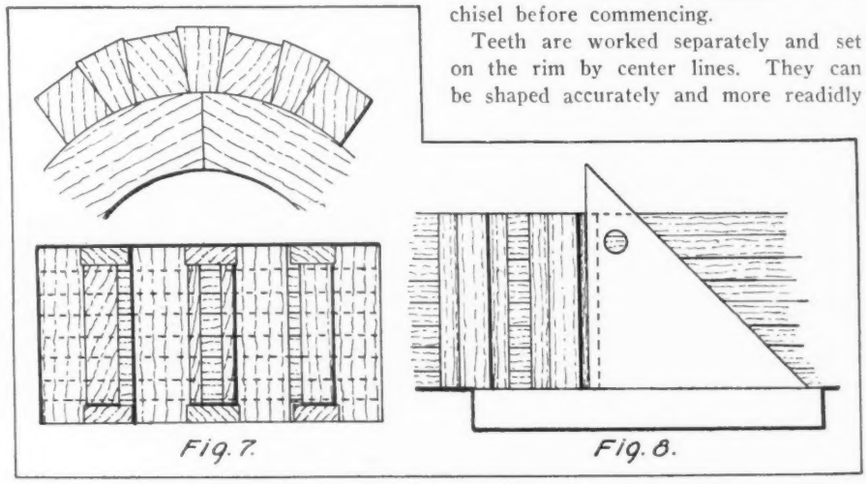


FIG. 7—REINFORCING BLOCKS ARE PLACED BETWEEN THE TEETH WHILE TURNING FIG. 8—USING THE SQUARE TO VERIFY THE POSITION OF THE TEETH.

with planes, than they can be cut with gouge and chisel, after the blocks have been affixed permanently to the rim. The object to the method lies in the difficulty of setting them on the rim to correct pitch, and square across.

The teeth are worked in a templet block several inches longer than the

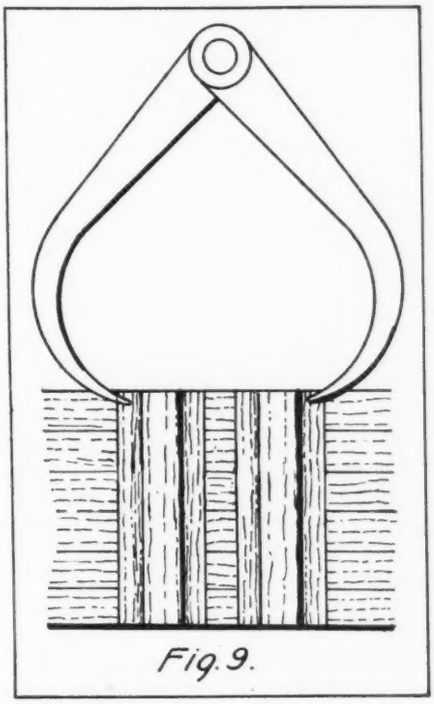


FIG. 9—THE CALIPERS ARE USED TO TEST THE PITCH

teeth, made of some hard wood, and notched to receive the blocks. These are prepared in strips, planed on one face to bed in the bottom of the recess cut in the block, and sawn off and squared to neat lengths with the chisel or the mitre cutter to fit in the templet block when driven in lightly with the hammer. They are then shaped with a round plane and a rebate plane by the guidance afforded by the contour of the block. A center line is scribed along the top of the tooth from a line on the block, and the tooth is knocked out with a pin thrust through a hole provided for the purpose in the back of the block. With the observance of ordinary care to avoid taking shavings off the templet block, the teeth should come out all alike. To set them correctly on the rim, a center line is squared down over the ends of each tooth from the longitudinal center already marked from the block. These lines are set against center lines pitched round the rim with spring dividers, or with a dividing apparatus when such is available. Alternatively, teeth may be set by their edges instead of by centers.

Although the teeth cannot be set with perfect accuracy by lines, yet approximate accuracy can be secured by subsequent checks. No attempt is made to nail them to the rim until the glue by which they are attached has dried, and before this sets, the caliper and square are brought into use, one to test the pitch, the other, the setting of the teeth square across the rim. The employment of the square is shown in Fig. 8. One edge is laid against a straightedge held across one face of the wheel rim, the other edge checks the side of the tooth. Fig. 9 shows the calipers testing the pitch. The pattern is left on the face plate on which it has been turned, while the teeth are being nailed and tested, and screwed on a wooden mandrel fastened down on the bench. This is better than attempting to hold the pattern body in a vise. It is held on the mandrel and can be turned round freely with no risk of squeezing the body, or of shifting the teeth.

Patterns that are delivered by hand must always have some draft, those which are drawn through stripping plates need not have any. A little taper on the rim is helpful, but taper in teeth is so objectionable that it is always kept as small as possible. It should not exceed the difference made by taking two or three of the finest shavings off one end more than off the other, the difference between a tight and easy fit when checked by the calipers.

Teeth are attached to their rims with dovetails when it is desired to secure the advantage of shaping the teeth with planes, without the risks of inaccurate

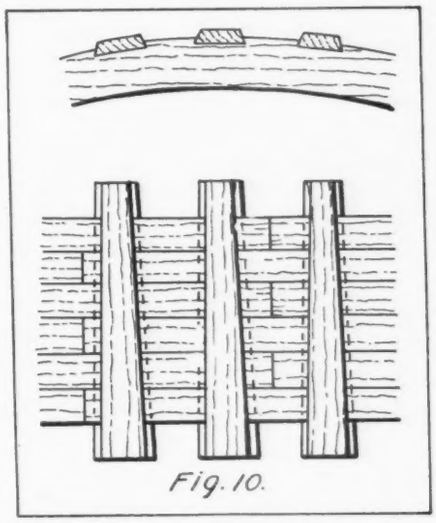


FIG. 10—THE DOVE TAIL BLOCKS ARE LEFT A LITTLE LONG TO ALLOW FOR VARIATION IN THE DRIVING FIT

setting by center lines on the teeth and the rim. The sequence of operations is as follows:

The rim having been turned, is pitched round, and the center lines squared across. A templet dovetail is made, having a center line by which it is set on these pitch lines, and the edges are marked therefrom. Shallow dovetails

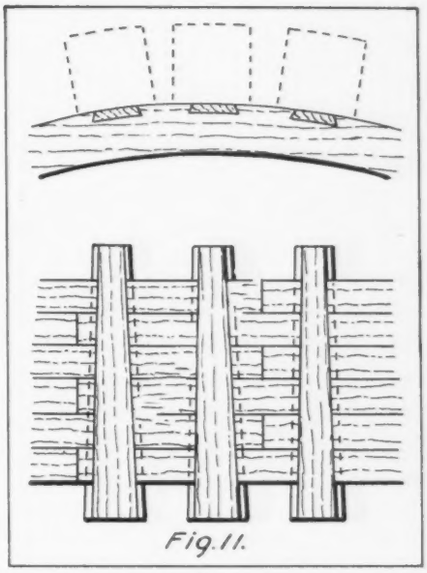


FIG. 11—THE TEETH BLOCKS ARE GLUED ON TO THE DOVETAILS

are cut by these lines with a fine saw, to a depth of about 3/16-inch, the depth having been set by lines struck round in the lathe on both faces of the rim. Then the depth is removed to these lines with a chisel and narrow rebate plane. The strips which are to form the dovetails are next fitted in by planing, their lengths are an inch or so more than the width of the rim, Fig. 10, in order to allow for variations in driving fits. When driven home with light hammer taps the ends are sawn off to about ⅛-inch longer than the width of the rim and the outer faces are turned flush with the periphery of the rim.

The blocks for the teeth are now sawn off from long strips of a cross section large enough to cut the teeth from, and about ⅛-inch longer than the width of the rim. They are hollowed with a plane to fit the rim, and glued on the dovetails, Fig. 11, using only a small quantity of glue, so that no excess shall work out beyond the width of the dovetails and get on the rim. After the glue has hardened, the dovetails are knocked out, carrying the teeth with them, and two or three small nails are driven through the backs of the dovetails into the teeth as a measure of security. They are then returned into their places. It is well now to mark them consecutively, 1, 2, 3, etc. The teeth are then turned. This can be done safely with light cuts, using a sharp gouge, and finishing with a keen scraping chisel. The precaution may be taken of chamfering the leaving edges of the tooth blocks with a chisel, to prevent risk of splitting out the edges, though with care, this is not necessary.

As the teeth have to be marked in place, the pitch lines and any lines of centers required for tooth radii are struck round on the turned ends of the teeth. To have these exactly alike on

both ends, as well as for convenience of turning the ends, it is usual to rechuck a pattern rather than face the rear ends of the teeth at the same chucking as the front. The pitching of the teeth is done round on one side first. It is convenient to divide round into multiples of the pitch first. Groups of four, six, eight, etc., may be thus divided, to be subdivided for the separate teeth. It is necessary to square a few pitches across, preferably at the multiple divisions, from which to start the pitching on the opposite side. A try square is hardly accurate enough for this because its stock has to lay round the curve of the wheel rim. A better method is to use a set square worked from a straight edge held across the face of the rim. Or to lay the face on a true drawing board, and set the square up from that, turning the square also round from right to left, to correct any possible error. Or to use the geometrical method of raising a perpendicular from a base line, setting the compass legs in center points on a circular line slightly within the edge of the rim.

From the pitch points the tooth thicknesses are pitched to right and left on the pitch line. When the centers for the tooth curves happen to come between the teeth, a templet can be used on which to locate them as in Fig. 6. It is of wood, fitting the curve of the tooth points, and having a tongue of zinc inserted, on which the center is located for the divider point.

After the teeth have been marked they are removed by knocking out the dovetails and having first set in both ends of the teeth carefully to the lines, they are roughed with chisels and gouges, and finished with planes. These ends are rubbed with red lead, the disappearance of which indicates when the teeth have been planed to the lines. They are then sand papered with a rubber, and returned to their places, in which they are glued permanently. If care is exercised at each stage, this is the most accurate method of constructing pattern gears, apart from the employment of mechanical aids.

There is one other modification in the fitting of tooth blocks which is adopted when the teeth are shaped with fly-cutters, one which provides for cutting radii in the roots. The tooth blocks are made wide enough to include the radius or fillet. Instead of fitting the teeth singly, as described, they are generally fitted in blocks wide enough to include three or four teeth. To avoid the keen feather edge where the radius merges in the rim, the rim is often turned under size by from ¼ to ⅜-inch leaving a thickness at the roots of ⅛ or 3/16-inch. The best pattern gears are made in this way and there is no risk of feather edges curling up after frequent molding.

Until recent years practically all pattern gears were made with double curved, cycloidal teeth, as in Figs. 1, 2 and 5 and struck by means of one standard generating circle by which interchangeable meshing of all gears of the same pitch is ensured. During recent years, the involute single curve has been adopted extensively. The double-curved teeth are not likely to become obsolete, since in the opinion of many they possess advantages over the others for severe duty and smooth running. As the majority of existing cast gears have been after this style, it is obvious that the calls for renewals must be met. The growth of the involute form, favored by the practice of cutting, tends to displace the cycloidal teeth in a considerable proportion of new designs of machinery.

Unfortunately, there is no commonly-accepted standard for either type of tooth either in respect of curvatures, or of lengths. The older proportions both for cycloidal, and involute teeth are generally abandoned for shorter teeth. With regard to curves, in those for cycloidal teeth, base pinions with radial flanks may have either 15 or 1 teeth, the diameter of the standard generating circle being equal to the radius of the base pinion. In the involutes, the pressure angle, Fig. 12, may range between 14½ degrees and 22 degrees. Here the curves are generated from the base circle, the tangent to which is the line of pressure, Fig. 12, and not as in the cycloids, from the pitch circle. Fig. 13 shows the method of marking the curve.

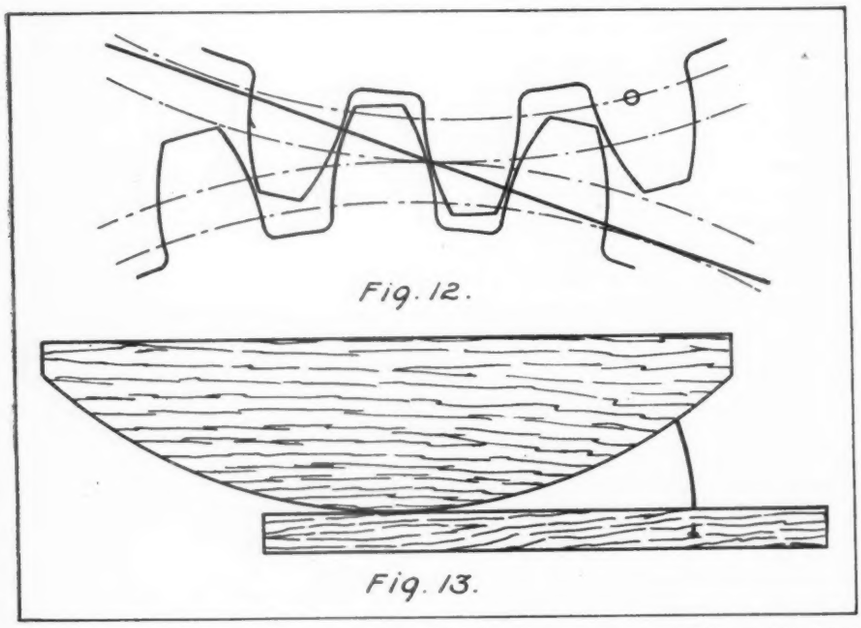


FIG. 12—IN INVOLUTE TEETH THE CURVES ARE GENERATED FROM THE BASE CIRCLE THE TANGENT TO WHICH IS THE BASE OF PRESSURE FIG. 13—IN CYCLOIDAL TEETH THE CURVES ARE GENERATED FROM THE PITCH CIRCLE

Organize Steel Casting Company

New York interests controlling the American Chain Co. have organized the Reading Steel Casting Co., with an authorized capital of $2,500,000 of preferred stock and 25,000 common shares of no par value, under the laws of New York state, and the latter company has purchased the business and assets of the Reading Steel Casting Co., Reading, Pa. The officers of the new company are: Chairman, W. D. Lasher; president, J. Turner Moore; treasurer, E. L. King; secretary, M. G. Moore. The five officers, together with W. F. Wheeler, comprise the board of directors. The executive headquarters of the new company will be located in the Grand Central Terminal building, New York, where the American Chain Co. has its headquarters.

Consolidated Interests to Build Foundry

To insure a supply of castings for their own use, as well as to take business for other consumers three corporations at Rockford, Ill., have formed the Forest City Foundry Co., with capital stock of $50,000 and will erect a foundry. The concerns interested in the new foundry are the Mechanics Machine Co., the National Lock Co. and the Rockford Lathe & Drill Co. Stock is also held by a number of individuals.

Pointers on Casting Monel Metal

Physical Characteristics of This Alloy Relate It to Steel in the Foundry Operations — High Melting Point Together with Large Shrinkage Make the Metal Difficult to Cast

BY REGINALD TRAUTSCHOLD

MONEL metal was successfully cast in 1908, when the propellers of the U. S. S. DAKOTA were poured. This was practically the first commercial use of the natural alloy smelted from the distinctive ore deposits of the Sudbury district, Ontario, Canada. Since then monel metal castings have been produced in a few foundries but today there is quite a lack of authentic information among foundries concerning the requirements for casting it successfully. The physical and thermal characteristics of the metal and their effects upon casting procedure are not generally appreciated. Too often there is a popular misconception that the metal resembles in characteristics the ordinary commercial alloys such as the brasses, bronzes, bearing metals or perhaps an alloy of the nickel silver class. However, monel metal is a decidedly individual and distinctive metal with quite special characteristics. It resembles the synthetic alloys in that it is noncorroding but in its other properties and founding characteristics it resembles steel.

High Temperature Necessary

The average composition of the metal is, nickel, 67 per cent; copper, 28 per cent, and other elements, chiefly iron, manganese, silicon and carbon, 5 per cent. The high percentage of nickel contained gives it a high melting point. In fact, only two other metals—nickel and steel—commercially cast must be subjected to so high a heat for casting. This is shown in the following table:

Metal	Temperature Degrees Fahr.	Cent.
Brass, Naval	1570	855
Brass, Red	1780	970
Low grade	1795	980
Brass, ¾ red, ¼ yellow	1690	920
Yellow—Cast	1645	895
Bronze, Leaded	1735	945
Bronze with zinc	1795	980
Copper (pure)	1983	1084
Iron, Cast—		
(White)	2075	1135
(Gray)	2264	1240
Gun metal	1825	995
Leaded	1795	980
Manganese bronze	1600	870
Monel metal	2480	1360
Nickel	2642	1450
Steel	2552	1400

All of the customary and characteristic difficulties encountered in securing satisfactory castings of high melting point metals are encountered with monel metal. It is failure to follow high temperature metal founding practice which has been the chief cause of most of the difficulties experienced in securing good castings by those not sufficiently familiar with the peculiarities of the metal. Much less trouble would be encountered if the fact was appreciated that the foundry requirements for casting monel metal more nearly resemble those for steel, and are quite radically different from those affecting the casting of brass.

Results of Tests

The strength of monel metal may be judged from the following results which are the average of 172 heats tested for the Isthmian canal commission.

Yield point	37,093 lbs. per sq. in.
Tensile strength	72,281 lbs. per sq. in.
Elongation in 2 in.	34 per cent
Reduction of area	32 per cent

The other physical properties of monel metal are as follows:

Melting point	1360° C. (2480° F.)
Specific gravity (cast)	8.87
Weight per cu. in. (cast)	0.319 lbs.
Weight per cu. in. (rolled)	0.323 lbs.
Coefficient of expansion, (20° C.—100° C.)	0.00001375 per 1° C.
Electrical resistivity, 256 ohms per mil-foot. (Temp. coefficient)	0.0011 per 1° F.
Electrical conductivity	4% (copper 100%)
Heat conductivity	1/15 that of copper
Shrinkage	¼ in. per foot
Hardness cast material	20-23 (Shore scleroscope)
Modulus of elasticity	22,000,000-23,000,000

A temperature in the neighborhood of 1550 degrees Cent., 2820 degrees Fahr., is essential for pouring monel metal. The metal must be subjected to such a heat in the furnace for some time, because its heat conductivity is low; about 1/15 that of copper.

Obviously, these heat requirements are too severe to permit the use of the customary brass melting furnace. A type of furnace adaptable to melting high temperature metals is necessary, such as an oil-burning furnace of the reverberatory type or an electric furnace. Crucible furnaces have been used successfully, but this type is not to be recommended. The electric furnace has proved the most advantageous, as a rule. The metal can be brought to heat rapidly in it and maintained at the required temperature. Thoroughly heated in such a furnace, the metal flows well even for small intricate castings.

A reverberatory furnace of a somewhat special construction can also be satisfactorily employed. It should be fired with oil and operated under natural draft. The floor of the reverberatory furnace first should be covered with a layer of charcoal without flux, before the metal in the form of ingots is charged. A blanket of slag, to prevent excessive oxidation of the metal, should cover the molten metal until shortly before tapping, when it should be partially skimmed.

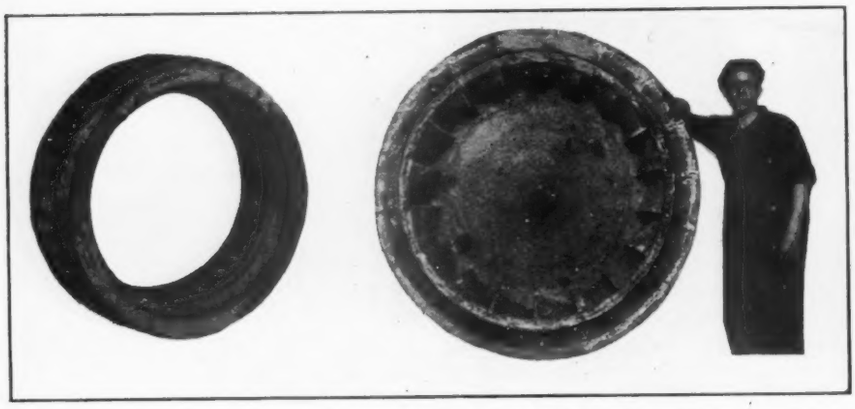
Though only the electric and oil types of furnaces are here recommended for melting monel metal, it is not meant that a crucible furnace cannot be successfully employed. One of the foundries which has been casting monel metal successfully for a number of years uses crucible furnaces operated on fuel oil. This particular foundry favors the crucible furnace, but its successful use has only been attained by discovering means of overcoming difficulties which are not present when employing either of the other two types of furnaces for melting monel metal.

Tapping monel metal should never be attempted until the charge has been thoroughly melted and brought up to a temperature of about 1550 degrees Cent. Before drawing off the molten metal, the blanket of protecting slag should be partially removed. During the pour magnesium should be employed as a deoxidizing agent, but otherwise no special agents should be used. Pouring should be accomplished as expeditiously as possible.

Refractory Molding Sand

Clay-lined ladles of the ordinary type are suitable for holding the molten metal. An iron stirring rod may be safely used, if care is exercised to prevent longer contact between the iron rod and molten monel metal than is necessary. Monel metal has a strong affinity for iron, therefore extended opportunity should not be presented for the hot metal to take up iron from the stirring rod. Though a small addition to the natural iron content of monel metal may be no special objection, care must be taken to see that this does not become excessive.

An important contributory factor in the production of sound monel-



MONEL METAL'S RESISTANCE TO CORROSION MAKES IT ADAPTABLE FOR TURBINE CASTINGS

metal castings is the quality and character of molding sand employed. The facing sand should be mixed with a generous proportion of sea coal. For fine work, an Albany, or brass molding sand is recommended. For larger castings the fine, strong and extra strong Lumberton sands, mixed with silica sand and sea coal, generally prove the most satisfactory.

Skin drying of molds for monel-metal castings is a safeguard almost always advisable. This is particularly true in the case of all heavy castings. As a rule, facing mixtures should contain little or no flour. Each foundry customarily has its own favorite formulas for facing mixtures. A mixture which has proved satisfactory in steel founding and which promises to be equally effective in monel metal work, despite the use of a small percentage of flour, is as follows: Old molding sand, 52 per cent; new molding sand, 26 per cent; sharp silica sand, 10 per cent; sea coal, 10 per cent, and flour, 2 per cent. After the pattern is drawn, the mold should be brushed with dry plumbago and carefully hand polished. The coated surfaces of the mold should then be painted with a solution of molasses water and the mold dried for some time after a hard skin has been formed. The unusually thorough skin drying is made necessary by the requirement that volatile matter within the thermal range of the molten metal be driven from the sand so far as possible. The principal molding difficulties are those pertaining to suitable venting and gating. Risers should be plentifully employed and large vents provided. Unless suitable vents are furnished the metal will not lie close to the sand, and porous castings will result. Generous fillets, also, should be provided.

Cores

The question of suitable cores for monel metal castings is also a matter of considerable moment. That the cores must be unusually strong and refractory to withstand successfully the thermal strains developed by the hot metal is quite obvious, yet they must break free, and clear readily. Beach sand, rather than bank sand, containing not more than a small percentage of binder, mixed with a high grade core oil is quite generally employed for making the cores for monel metal castings. Core mixtures which have proved satisfactory for steel castings, have also been used with excellent results. However, beach sand and core oil is quite generally to be recommended for small cores. A suitable and typical mixture is made by intimately mixing beach sand with from 1½ to 2½ per cent by weight of boiled linseed, or high grade core oil. Cores made from such a mixture may be found at times not to be sufficiently hard for large cores, despite thorough baking. It is then necessary to add a certain proportion of ground fireclay to increase the core hardness. A special core mixture said to be satisfactory for large monel-metal cores is composed of silica sand, 80 per cent; ground fireclay, 10 to 15 per cent; flour 4 to 8 per cent, and boiled linseed, or high grade core oil, 1 to 2 per cent. When strains are liable to occur flour should not be used in the core sand mixture owing to the ease with which a core free from flour releases. Other suitable core mixtures for larger monel metal castings are:

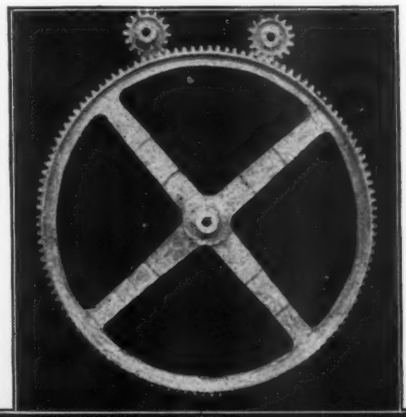
Silica sand mixed with 10 per cent ground fireclay and tempered with a 5 per cent solution of molasses water.

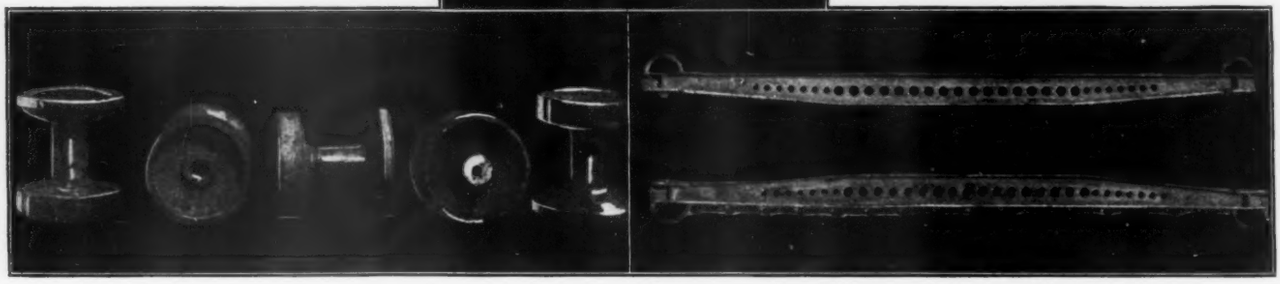
Silica sand mixed with a small proportion of boiled linseed, or high grade core oil and the core treated with a silica wash.

Equal parts of silica sand and silica flour tempered with molasses water.

Molds for monel-metal castings have heretofore been chiefly bench made, but excellent results have also been secured with the use of molding machines. In fact, machine molding would appear to be as practical for monel metal as it has proved to be for steel castings.

The principal requirements for successful and economical molding are the accurate mounting of patterns and uniform and careful ramming. The pattern should be firmly and accurately mounted on the molding board. In the case of machine molding it is generally advantageous to mold the drag on a roll-over machine and make the cope on a stripping plate. The ramming should be performed mechanically by the jar, or jolt, method and





A VARIETY OF CASTINGS ARE MADE FROM MONEL METAL—STRENGTH AS WELL AS RESISTANCE TO CORROSION IS SECURED

all possible mechanical aids should be employed for handling the flask, as it is imperative that it be disturbed as little as possible.

If the crucible furnace is disregarded, the reverberatory air furnace is quite generally employed for heats in which only a few hundred pounds of monel metal are melted, but the wisdom of such practice is open to question. For larger heats, a tilting electric furnace proves the more economical, as well as considerably more convenient. As such a furnace can be used for small heats, if its initial and operating costs are not too high, it usually proves the more economical in the long run for all monel-metal founding.

An advantage of the electric furnace is that the melting of the metal can be accomplished rapidly, on account of the intense temperatures that are developed. The ease with which the required temperature can be maintained in the electric furnace is particularly advantageous, for unless the consistency of the molten metal is correct for free flowing, and is so maintained throughout the heat, unsatisfactory castings and excessive scrap are almost certain to result. Maintaining the proper molten metal consistency to guard against the chilling of the metal is, in fact, one of the chief factors in the successful casting of monel metal.

Factors for Ascertaining Approximate Weights of Monel Metal Castings From Weight of Wood

Pattern	Factor	Pattern	Factor
Baywood	10.4	Maple	11.7
Beech	10.3	Oak, red	11.5
Birch	12.0	Oak, white	11.7
Butternut	13.2	Pear	13.3
Cedar	15.9	Pine, white	15.9
Cherry	12.2	Pine, yellow	13.3
Linden	14.7	Whitewood	15.7
Mahogany	8.3	Walnut, black	13.2

Recapitulation

The essentials of successful founding of monel metal may then be concisely stated as:

Obtaining suitable metal temperature—about 1550 degrees Cent. (3000 degrees Fahr.).

Proper venting and gating of molds, with a plentiful use of risers.

The avoidance of any facing mixture or core content liable to produce excessive gaseous formations.

The avoidance of any substance in cores or facings which may fuse into the casting.

Thorough baking of cores and skin-drying of molds.

Castings varying in weight from a few ounces to 25,000 pounds each have been successfully poured from a wide variety of patterns from the simple to the complex. Ship propellers, pump linings and fittings, water wheels, turbine castings and a variety of castings ranging to the heads for golf clubs are made from monel metal.

These examples of monel-metal castings are presented merely as indications of the wide and growing demand for castings of this distinctive metal. Monel metal has established itself as important for many industrial purposes and every up-to-date foundry should be familiar with its characteristics and the approved processes to be followed in casting it.

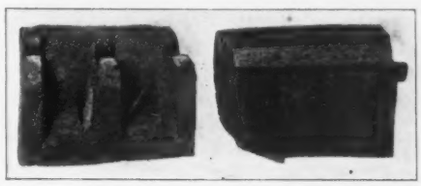
The warning to be wary of the scrap added to the charge when charging the furnace, will prove valuable to the foundry contemplating working with monel metal for the first time, if it is heeded. A considerable amount of the scrap metal offered on the market is not pure monel metal, but some inferior synthetic alloy, or monel metal which has been doctored to such an extent as to lose much of its valuable characteristics. Good shear scrap can be used with some assurance of satisfactory results, but floor scrap is much more dangerous. It is apt to be mixed with iron in unduly large proportions and with other metals which are not conducive to a high grade casting mixture.

Monel metal is not a safe metal for the jobbing foundry to experiment with. Molding practice and the procedure for handling monel metal must be standardized, the metal must be poured at suitable temperatures and a high degree of molding skill is essential.

Monel metal is too expensive to experiment with, failures are too costly and unsatisfactory results are only to be avoided by a proper appreciation of the special skill required for the successful founding of the metal. However, the metal is being very successfully cast and through proper standardization of founding procedure and attention to pouring temperatures the defective casting loss, which otherwise is certain to be high is being kept down within reasonable limits.

Cast-Iron Blocks Conserve Cupola Lining

With a heavy tonnage of metal to melt it is found economical to charge the cupola mechanically instead of by hand. Where pieces of scrap and pig iron are thrown in the cupola by hand, one piece at a time, the charge is built up regularly and little damage is done to the wall around the charging doors. However, by the mechanical method cars of metal usually are brought to the doors of the cupola and then tilted by a crane or a hydraulic ram so that the metal slides from the car into the furnace. This is quicker and saves considerable labor expense, but it has two disadvantages. When the metal slides into the cupola it strikes against the opposite wall and tends to pile up on that side unequally.

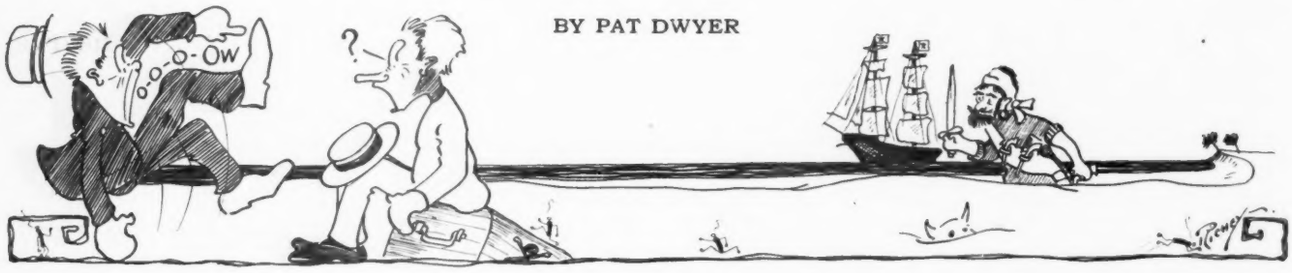


THE BLOCKS ARE CAST HOLLOW

This portion of the cupola does not get heated like the section further down near the melting zone and therefore, it is possible to line it with material which will better withstand the abrasive action of the falling charge. Some foundries take advantage of this to use different expedients to increase the life of the lining about the doors. The accompanying illustration shows cast-iron blocks of a type sometimes used to line cupolas about the doors. The block at the right sets as it is placed in the cupola while the one to the left is reversed to show the rear view. From this it may be seen that the blocks are made hollow to decrease the weight and to save expense. The recesses in the supporting webs, as may be seen in the figure to the left fit into the rib shown on top of the other block. A circle of these castings is formed around the cupola from a point 1 foot below the charging doors to the same distance above the doors. A cast-iron false sill is placed in each of the charging doors before starting operations. This sill is 1 foot high, so the effect is the same as though the cast iron lining was extended 2 feet below the doors. Such a lining lasts about four months.

Bill Enters the Ring with the Foundry Jinx

BY PAT DWYER



BACK in the old days when we were boys together, Bill's chief ambition was to become a pirate captain and sail up and down the Spanish Main in a long, low, black, rakish craft flying the *Jolly Roger* from her mast head. Drake's, Flint's and Morgan's men were regarded with the deepest admiration and envy and his constant regret was that he had been born too late to accompany John Silver and the other gentlemen of fortune in Flint's ship the famous old WALRUS when she carried that august company safely home with her rail awash from the weight of treasure aboard and her decks ankle deep in the hot red blood.

Instead of going to sea, serving his time and eventually taking out a card as a journeyman pirate, Bill went into the foundry, where in addition to learning the business, he acquired a working knowledge of some phases of the English language which would have reflected credit on the roughest buccaneer who ever perjured his soul for a bottle of rum.

He no longer wishes to take part in scenes of carnage or do deeds of violence but he will stop at any time to enjoy a dog fight and there is not a prize fight or a boxing tournament pulled off within a 100 miles of the city in which he lives but he is bound to be at the ringside. Recently he invited me to accompany him to one of these events and see some real sport.

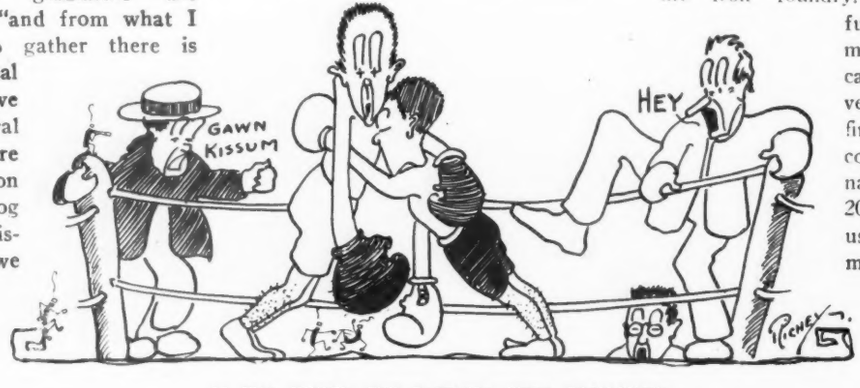
"Five pairs of gladiators are matched," said he, "and from what I have been able to gather there is going to be some real rough work. I have been told that several of the bruisers are doing their training on a diet of raw dog meat. Sounds promising, eh?" Well, we went and during the performance, the spectators exercised their inalienable right, guaranteed them under the provisions of the constitution by expressing their opinion of the contestants in the most free and open manner. I was under the impression that the show was simply a boxing exhibition, but evidently most of those present, including Bill, thought otherwise. While the gentlemen in the ring were engaged in beating each other up he contented himself with smiling happily and clapping his hands, but when they clinched or danced around each other or indulged in any of the well known tactics practiced by experienced ring performers for passing the time, he implored the referee in the most earnest manner to "make those birds fight."

I think the only bout that afforded him real pleasure was the last, between two heavyweights. They *could* hit each other and they *did* hit each other some grievous wallops. It was scheduled for a 10-round go, but in the ninth round one of the heroes got on the inside track. He pounded his adversary to a pulp and knocked him out, to the great joy and delight of every person present with possibly one pulpy exception.

On the way home, I said to Bill that I wouldn't take all the money in a fair sized bank and take the beating one of the men received that afternoon. Bill said that if they gave him a shillalah and suspended all the rules so that he could fight any way he pleased and turned him loose among a flock of certain people he could name he would be willing to take a beating for the pleasure the occasion would afford him.

"Seriously, though," said he, "while we may differ in opinion and regard the boxing game with admiration or otherwise, there is no gainsaying that a man must have physical courage in a rare degree to take punishment and not lose his temper. However, there are other forms of suffering endured sometimes which try one's courage just as effectively as being pounded out of shape by a superior antagonist. If you ever lost a casting several times in succession and were at a loss to account for it, you will know what I mean. I'll tell you of an experience I had one time in which I was knocked out and had to take the count.

"I am not much of a believer in jinxes, hoodoos, and other forms of bad luck which infest foundries to a greater degree than any other form of industrial establishments; but I am free to confess that I came nearer to believing in their existence then than at any other time in a fairly extensive foundry career. The cause of all the trouble was a brass pump plunger 8 inches in diameter and about 5 feet long, having a metal thickness of 1¾ inches. A number of pumps in the plant were equipped with the same type plunger and consequently the job came into the foundry several times a year. The brass shop in this plant was located in part of one of the side bays in the iron foundry. It had four pit furnaces for melting miscellaneous brass castings, and one reverberatory furnace fired with bituminous coal. The latter furnace had a capacity of 2000 pounds and was used for melting the metal for the blast-furnace tuyeres, which as you know are composed of practically pure copper.



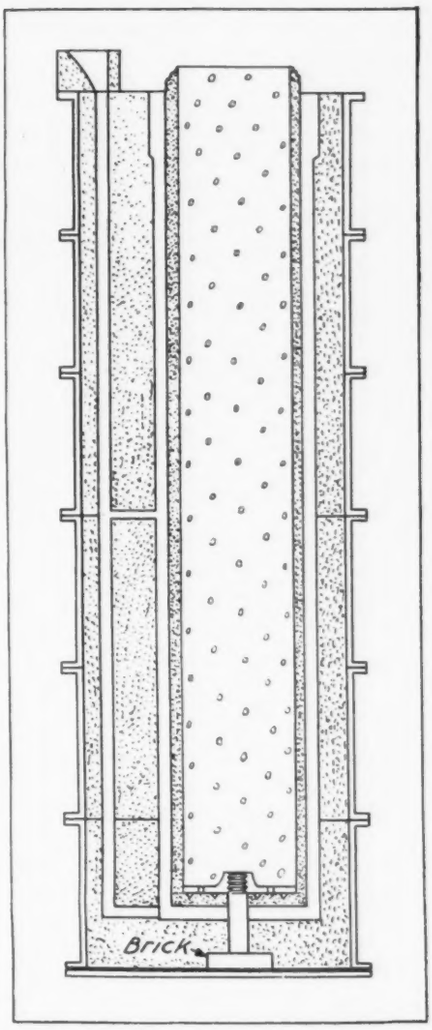
IT WAS HINTED THE BATTLERS WERE ROOM-MATES

About 1 pound of phosphor-tin was added to each 100 pounds of copper in the ladle.

"The plunger casting at first was made from a split pattern, horizontally in green sand. The two halves of the core were made of dry sand in a half core box and pasted. Sometimes the casting was good and at other times while apparently all right when leaving the foundry it was condemned in the machine shop after the first cut had been taken off. Skin drying then was tried but with indifferent success and finally the mold was dried in the oven and poured on end. This treatment gave satisfactory results on several occasions and then it was decided the next time the job came in to nail the two halves of the pattern together and mold it on end in a round iron flask, the core to be swept up in loam.

"No special precautions were considered necessary on the first casting. The mold was parted at the bottom and also at a point about half way up. An upright runner was employed, terminating in a gate at the bottom. An additional gate was cut at the half way joint to facilitate the flow of the metal and keep it fluid on its long course into the mold. The metal was melted in two crucibles and afterward dumped into one of the iron foundry ladles which then was picked up by the crane to pour the mold. The top of the mold was left open and the square portion which formed the top of the casting was carried up for about 6 inches to serve as a sink head or feeder. The casting poured nicely and the metal came up into the riser with only a slight flutter. It was shaken out next day and the core removed. The casting was perfectly smooth, the only chipping necessary being required to remove the gates; but you should have seen it after the machinist had taken a cut off. It was like a honeycomb from top to bottom.

"The blame first was laid on the mold which, it was thought had not been sufficiently dried. Another mold was made and dried thoroughly, but



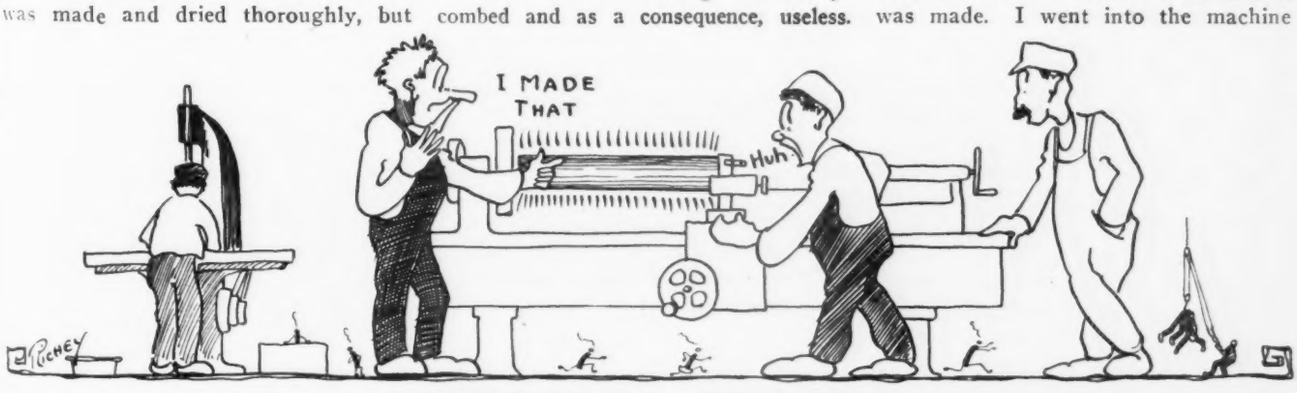
ASSEMBLED MOLD FOR PUMP PLUNGER—THE STRAP ACROSS THE TOP FOR HOLDING THE CORE DOWN IS NOT SHOWN

the result was the same. In the next one each course of sand was vented with a large vent wire and fine coke laid in a ring at each joint of the flask sections. That did not cure the trouble. Then it was decided that the trouble lay in the metal and special precautions were observed in melting it. On one occasion broken glass was employed to cover the molten metal in the pot and later, charcoal was used for the same purpose but in each instance the casting was honeycombed and as a consequence, useless. When the sixth casting turned out to be a waster I went over to the master mechanic's office to tender my resignation. We were on quite friendly terms and under our joint incumbency the foundry previously had established several records of a different character from the one about which I am telling. He was a highly educated young man from the north of Ireland and he told me in a profane and friendly manner to keep on until I got a good casting. 'It will be time enough for you to quit when I tell you to,' said he.

"I went back to the foundry and decided to give the proposition one more shot and if the next casting was bad I was fully determined to fly away, resignation or no resignation. Each time the mold had been poured the vent from the core apparently had come off freely and my mind had been so prejudiced at first with the defective mold and later with the defective metal theory that the possibility of the core being at fault had not occurred to me. I now examined the core and thought I saw the nigger in the woodpile.

"I neglected to state at the beginning that the casting was closed at the bottom with the exception of one 1¼-inch hole in the center. The coremaker, of course, had selected the easiest way of making the core and had swept it up with loam and several thicknesses of hay rope on a piece of 1¼-inch pipe. The pipe was perforated, it is true, but the gas had to work through such a thickness of loam that it did not escape freely but caused a constant boiling of the metal while the mold was filling.

"I had a new core barrel made of 3½-inch pipe, closely perforated with ½-inch holes. One end was threaded on the inside to receive a perforated cast-iron disc. A short piece of 1¼-inch pipe was screwed into the disc to serve for a core print. One thickness of hay rope and one coating of open loam were sufficient to bring the core to the proper diameter. This core was used in the next mold that was made. I went into the machine



NO NEED TO PROVE BILL IS CLEVER—HE ADMITS IT

shop on the following day to see what the casting looked like in the lathe. Those fellows you read about who are rescued just as they are going down for the third and last time had nothing on me when I saw that shining cylinder whirling around and looking like a shaft of refined gold.

"The master mechanic came along while I was standing gazing in admiration at the work of art. He stopped also and said, 'Well, Bill, I see you caught the jinx and nailed his quivering hide to the fence.'

"'Yes,' I said, 'but believe me this jinx hunting business is no game for a man with a weak heart, me for the wild African desert next time."

How and Why in Brass Founding

By Charles Vickers

Casting Nickel Silver

We are casting nickel silver of compositions varying from copper, 50 per cent; zinc, 25 per cent; nickel, 25 per cent to the lower grades consisting of copper, 55 per cent; nickel, 18 per cent; zinc, 22 per cent; lead, 5 per cent. We have had fair success, but there appears to be some oxidation and we would like to learn of a suitable deoxidizer to promote sound castings.

Also how should the metals be charged into the crucibles? What will produce the best results in melting, coke, oil, or gas fuel? What type of gates are best to use to run the castings? Will bottom-pour crucibles produce the best results? What is the best skimming device to use? Can scrap metals be used?

To make nickel silver, first charge the nickel into the bottom of the crucible, and place some pea-size charcoal on top. Then place on this the copper and scrap until the crucible is filled. Use a deepener on top of the crucible to get all the charge into the crucible while cold. After all the metal has been charged place a covering of charcoal on top and a small handful of borax. Now melt, and melt rapidly, there must be no soaking in the fire; the furnace whether coke-fired, oil-fired or gas-fired that will melt the most cleanly and quickly is the best for the purpose. When the metal is melted hot, add the zinc gradually. If the alloys are intended for rolling purposes, it is not advisable to use all scrap metals, as the sheets will crack; but rather use at least 50 per cent new metals, and while melting, keep the poker away, have plenty of heat so the mass of metal will quickly liquify. As a deoxidizer use 0.25 per cent of manganese copper.

It is not possible to offer suggestions regarding the method of gating unless the shape of the castings is known. Common sense will suggest the gates be large enough to get the metal into the mold rapidly enough to run the castings. Further they should be disposed with a view of preventing the entrance of dross, sand and other dirt into the castings. Bottom-pour crucibles will not produce the best results, because the tube leading to the bottom of the crucible never reaches sufficiently near the bottom to do any good. Usually, the tube terminates half way up the crucible side, and is a delusion and a snare. The small size of the hole also, makes it impossible to pour the molds rapidly enough, as the metal dribbles out, then overflows the top if the crucible is tipped in an effort to get results. Bottom-pour crucibles to be of value, must be made especially to blueprint, in which case they give excellent results.

The best skimming device is a common piece of band iron, bent to a crook at the skimming end, and used by a skilled, careful man.

Nickel Castings Show Pin Holes

We would like to learn of a method of making nickel silver castings come solid as the castings we make of this alloy frequently are filled with pin holes. As a source of nickel we use spent bullets after the lead is run out, and mix in the following proportions: Bullet shells, 26 pounds; cartridge, 303; brass, 12 pounds; zinc, 1½ pounds, and lead, 2 pounds. This makes a mixture that is white and otherwise satisfactory. We use gas coke for melting.

The composition of this metal is approximately, copper, 70.30 per cent; nickel, 12.52 per cent; zinc, 12.30 per cent, and lead, 4.80 per cent. To 100 pounds add 4 ounces of 30 per cent manganese copper as a deoxidizer. If this is not available and the castings are not intended to withstand pressures add one ounce of aluminum per 100 pounds of the alloy. In melting the alloy use a flux of fluorspar and lime; 3 parts fluorspar to one part lime, and if this makes the flux too fluid decrease the fluorspar and increase the lime.

Care Is Necessary with Phosphor Bronze

We are submitting for inspection a fractured section from a 1-inch cast bar of bronze of the composition following: Electrolytic copper, 90 pounds; Straits tin, 10 pounds; 15 per cent phosphor copper, 6 pounds. The alloy was made in a coal-fired furnace at a temperature of approximately 2200 degrees Fahr. Charcoal was used as a covering and the phosphor copper was added about five minutes before the crucible was pulled. The pot then was skimmed, and to cool it to a temperature of about 1850 degrees Fahr., which was considered proper for pouring, a gate of the same metal was added. During the five or 10 minutes the metal was being cooled, the surface was left exposed to the atmosphere. Green-sand molds were used. The phosphorus is purposely high, as the specifications calls for from 0.6 to 0.9 per cent of it.

The temperatures were taken with a pyrometer, and it was noted that the metal after being drawn from the furnace and skimmed and stirred, read about 100 degrees hotter than when measured in the furnace. This peculiarity has been noted on other occasions and does not appear to be due to an inaccuracy in the readings. After the metal has solidified in the molds, a small quantity of tin seems to ooze or bubble through the top of the gate. Is this tin thrown out of the solution, and if so what is the cause of this?

Will you kindly advise as to the precautions to be taken in order to secure a sounder and more uniform structure, stating temperatures, proper time for adding the phosphorus, etc.? We will thank you for an early consideration of the matter.

The composition of this alloy is as follows: Copper, 89.71 per cent; tin, 9.44 per cent; phosphorus, 0.85 per cent. This agrees closely with the formula for a bearing alloy given by A. Philip several years ago before the British Institute of Metals. This al-

loy also follows: Copper, 89.70 per cent; tin, 9.40 per cent; phosphorus, 0.78 per cent; total, 99.88 per cent. The properties of this alloy are given as follows: Tensile strength, 45,248 pounds (202 tons) per square inch; elongation, 12 per cent.

The alloy is used as a bearing metal because when this amount of phosphorus is present in an alloy, a compound of phosphorus and copper is formed containing three atoms of copper to one of phosphorus, or about 86 per cent copper and 14 per cent phosphorus. Anyone who has used 15 per cent phosphor copper knows this compound is hard and brittle; it is scattered throughout the mass of the alloy as hard nodules upon which the bearing may ride, thus the alloy is suitable for bearings because it resists abrasion owing to its hardness. Such metal to get a perfectly even bearing surface has to be perfectly fitted to the shaft that revolves in it. It will not give and come to a bearing like a plastic bronze; if not well fitted it will run hot, therefore, it can only be used in situations where a perfect fitting of bearing to shaft is possible. The alloy is one to cause difficulties in foundry work, due to the fact the phosphorus is too high for the percentage of tin. An alloy containing approximately 10 per cent of tin, is at its best when merely a trace of phosphorus is added. Thus 0.10 per cent of a 15 per cent phosphor copper added to such an alloy will give higher physical properties in test bars than 0.25 per cent phosphor copper and 0.25 per cent phoshor copper than 0.5 per cent phosphor copper, and so on. Foundry difficulties arise from the fact that when two or more copper hardening elements, such as tin and phosphorus are present in an alloy of copper, it becomes necessary to adjust the two, so there is room for both, otherwise, one will be crowded out as the temperature falls. Thus when enough phosphorus to form copper phosphide is added to an alloy of 10 per cent tin a rich alloy of copper-tin-phosphorus will be squeezed out after the alloy has solidified.

In the case of an alloy consisting of copper, 88.55 per cent; tin 11 per cent; phosphorus 0.45 per cent, the composition of the beads of metal that oozed from the risers was as follows: Copper, 79.13 per cent; tin, 19.99 per cent; phosphorus, 0.34 per cent. The effect of other impurities is similar. Beads of alloy are squeezed out as the casting solidifies, which may contain up to 30 per cent tin, with a relatively large amount of the impurity.

In this case, the sample submitted is far from being homogeneous in structure. It consists of a mechanical mixture of two alloys, one of a coppery color, the other much lighter. Evidently the alloy has split up while cooling and the two alloys have intimately mixed. The question arises whether this is the best alloy for the purpose. If this is decided in the affirmative, then it must be cast in such a manner that no time is given for either the formation of two alloys, or for the rich copper-tin constituent to liquate.

The sample submitted is from a bar one inch diameter, cast in sand. There should be no difficulty in casting such bars in graphite molds, which would ensure quick chilling and metal of superior strength and qualities. Varying the pouring temperatures and method of making the alloy has little influence upon the structure of the alloy. The present practice is good and difficult to improve upon. It is a case of either changing the alloy itself, or the method of casting the same.

Difficulties With Nickel Alloy Castings

We have experienced considerable trouble while making castings of a mixture containing 20 parts nickel; 12 parts copper, and 3 parts phosphor tin. When the castings are turned, we find blow holes. We first run the alloy into ingot, then remelt the same for castings. We shall be pleased with any suggestions you may offer.

Figured in percentages the alloy given would consist of nickel, 57.13 per cent; copper, 34.30 per cent, and phosphor tin, 8.57 per cent. If the proportions have been correctly given this is a peculiar alloy. Assuming that the phosphor tin contains 5 per cent phosphorus, there would be 0.4285 per cent of this element added. With this composition, the addition of other deoxidizing elements is out of the question. This would only complicate the situation as the reverse of an improvement could be anticipated. If the composition of the alloy as figured in percentages is correct, and no change can be tolerated in the proportions of nickel, copper and tin, the best course would be to substitute ordinary tin for the phosphor tin, thus omitting the phosphorus entirely. In place of the phosphorus, add 1 per cent of manganese copper containing 30 per cent manganese, thus adding 0.30 per cent manganese. The manganese copper should take the place of an equal amount of ordinary copper. If the manganese fails to produce sound castings, omit the phosphorus, and shortly before removing the metal from the furnace add as a deoxidizer, 2 ounces of magnesium. It will be advisable to use a phosphorizer to introduce the magnesium, and to stir it into the alloy before withdrawing the phosphorizer. The following alloy is very stiff, also white in color. The alloy follows: Copper, 65 per cent; nickel, 32.25 per cent; aluminum, 2.50 per cent; manganese copper, 0.25 per cent.

Crucible Making Deemed Impractical in Shop

We would like to obtain information for making crucibles in order to make our own crucibles for melting brass.

The quality of the clay is important in making crucibles. Such a clay as Klingenberg is suitable. The clay is finely ground, mixed with water and allowed to stand for 24 hours. To every 1000 pounds of Klingenberg clay is added 1550 pounds of Ceylon graphite and 375 pounds of granular quartz, having a grain size of 0.08 inches diameter. The graphite and the clay must be thoroughly mixed and kneaded, then the sand is added. The mixing of the various ingredients is exceedingly important, and when mixed the clay is made into batches which are stored in cool, damp cellars to gain plasticity. The clay is then passed through a sausage machine. The strings are balled up again and are made into molds on a potter's wheel. After shaping the crucibles are dried slowly, and finally they are burned in a special kiln.

The manufacture of crucibles is a highly specialized industry. No foundry can afford to attempt to make their own, even at present high prices. We suggest that crucibles be purchased from the makers, and no attempt be made to construct them in a foundry.

Metal Like Aluminum

Will you kindly advise us where we can obtain a metal that can be handled like aluminum; one that has the same color, and properties, but which will cost less. We make a small can opener and find that aluminum makes an attractive handle, but the cost of that metal is too high. What we want is a cheap alloy with a nice appearance which will not require a finish of any kind in the way of enamel, etc.

We would suggest the use of a zinc base alloy for the purpose outlined in the query. An alloy of zinc 84 per cent; copper 10 per cent, and aluminum 4 per cent would be suitable. This alloy has much the appearance of aluminum, takes a high polish, is hard and in every way suitable for the handles such as you have been making.

Electrical Melting Of Alloys—XII

Efficient Operation is Measured by Continuity of Output — More Power Needed Per Ton Melted When Furnace Cools Between Heats— Cost Per Kilowatt Hour Lower in Large Installations

BY H. W. GILLETT

AFTER selecting a suitable type, make and size of electric brass furnace for the work in hand and properly installing and locating it in the shop, the next problem is to operate the furnace to best advantage. One feature is prominent in such operation. Everything that tends toward increasing the production from a given furnace tends to reduce the melting cost per ton. Everything that tends to decrease production tends to increase the cost.

Continuous, 24-hour operation is required to allow any electric furnace to show its maximum efficiency. Probably no firm melts brass that cannot do it more cheaply in some electric furnace than by any other means, if its production can be spread over the whole 24 hours. Most electric furnaces will produce in 24 hours more than three times what they can produce in 9 hours. In 16 hours they can produce at least twice what they can in 9 hours.

By operating two or three shifts instead of a single shift, $10,000 worth of equipment will do the work of $20,000 or $30,000 respectively, and the interest and depreciation charges per ton disappear accordingly. Fortunately, the traditions of the wrought brass industry favor night work, since the old pit fire was not so bad to handle at night as in the hotter day time.

Castings made in simple sand molds, such as railroad car bearings, can generally be made well on a night shift, but as the complexity of a sand mold increases, the disadvantages of night molding increases. The difficulties are primarily those of illumination which can be overcome, and of lack of trained foremen and superintendents for night work. If the night shift is a steady thing instead of merely an irregular one when a spasmodic need for production calls for it, there is no reason why the problem of superintendence should be insurmountable. At any rate, from the point of view of melting, continuous operation, or at least two 8-hour shifts, is attractive. Not only does this lengthened operating time cut the interest charge, but it lowers the power cost per ton, and does it in several ways. First, it decreases the idle time in which the furnace cools off, so that the first heat after an 8-hour idle period is faster and takes less power than after a 15-hour idle period. In this way the extra power required to make up for lost heat becomes a smaller percentage of the total used and thus, the power used per ton is less.

Moreover, the power that is used costs less per kilowatt hour because power contracts contain two factors, the demand, and the energy charge. The demand charge is based on the maximum load, and is a sort of interest charge to pay the central station for setting aside part of its generating equipment for its customers' use. Obviously, the central station needs only half as much equipment to supply 300 kilowatts to one furnace, whether it is used one, two, or three shifts, as to supply 600 kilowatts to two furnaces at the same time. The power factor penalty or premium carried by many power contracts is analogous, a low power factor means that just so much more of the central station's generating equipment is tied up.

The other factor, the energy charge, pays for coal, labor, depreciation, etc., which vary with the amount of power supplied. The more power used, the less is charged for each unit of the added increment. In other words, one gets power cheaper by buying in large quantities. Hence, it may happen that the cost of power for a single electric furnace might be too high to allow that furnace to show a saving, while by going more completely over to electric melting, and installing several furnaces, the cost of power might drop so that the battery of furnaces would show a saving. This will be made clearer by including a computation which the writer has already given elsewhere*. Similar points have been brought out by Berlin** for steel furnace operation. Suppose there is a maximum demand of 300 kilowatts and that the average power consumption per ton of metal is 335 kilowatt hours per ton on 9-hour operation, 275 on 18-hour and 250 on 24-hour operation; the total power used per day is then about 2000, 3575 or 5250 kilowatt hours for the three cases figuring 8, 13 and 21 heats a day respectively. In a 25-day month this means 50,000, 90,000 or 131,000 kilowatt hours per month.

Assume that the plant, before it installed its electric furnace equipment, had a maximum demand in lights and motors of 200 kilowatts, and used 20,000 kilowatt hours per month for those purposes. Taking a concrete case where the power contract calls for a demand charge of $1.80 per kilowatt per month for the first 50 kilowatts and $1 per kilowatt per month, for all over 50 kilowatts, and where the energy charge schedule is 2 cents per kilowatt hour for the first 2500 kilowatt hours per month, 0.8 cent per kilowatt hour for the next 35,000 kilowatt hours per month; 0.5 cent per kilowatt hour for the next 310,000 kilowatt hours per month and 0.4 cent per kilowatt hour for all over this amount per month.

The 200 kilowatt hours for lighting and motor power cost as follows:

50	x	$1.50	=	$ 75.00
150	x	1.00	=	150.00
Demand charge			=	$225.00
2500	x	$0.02	=	$ 50.00
17500	x	0.008	=	140.00
Energy charge			=	$190.00

Total $415, or 2.075 cents per kilowatt hour used.

With the 300-kilowatt furnace the plant has 500 kilowatts maximum demand, and 70,000, 111,000, 150,000 kilowatt hours are used per month on the three assumptions. These will be figured as follows:

50 x $1.50	= $ 75.00		
450 x 1.00	= 450.00		
Demand charge	= $525.00		
Energy—Case No. 1			
2,500 x $0.02	= $ 50.00		
35,000 x 0.008	= 280.00		
32,500 x 0.005	= 162.50		
70,000 Total kilowatt hours used.	492.50	Energy charge.	
	525.00	Demand charge.	
	$1017.50	Total charge.	
Less previous charge for lights and motors	415.00		
Total charge for electric furnace power	$ 602.50		

602.50—total charge
———————— =1.205, shows
50,000—kilowatt hours used

the electric furnace power cost to be 1.205 cents per kilowatt hour.

*Gillett, H. W., Utilization of Electric Brass Furnaces, Jour. Ind. Chem. Eng., Vol. 11, 1919, p. 664.

**Berlin, W. G., Power Problems from the Point of View of the Furnace Operator, Trans. Am. Electrochem. Soc., Vol. 37, 1920, p. 367.

In case No. 2 the demand charge is the same but the energy charge is:

2,500 x $0.02 =		$ 50.00	
35,000 x 0.008 =		280.00	
72,500 x 0.005 =		362.50	
110,000	Total kilowatt hours used.	692.50	Energy charge.
		525.00	Demand charge.
		$1217.50	Total charge.
Less previous charge for lights and motors		415.00	
Total charge for electric furnace power		$ 802.50	

$\frac{\text{802.50—total charge}}{\text{91,000—kilowatt hours used}} = 0.89$, shows the furnace power cost to be 0.89 cent per kilowatt hour.

In case 3 the demand charge is also the same, but the energy charge is:

2,500 x $0.02 =		$ 50.00	
35,000 x 0.008 =		280.00	
113,500 x 0.005 =		567.50	
151,000	Total kilowatt hours used.	897.50	Energy charge.
		525.00	Demand charge.
		$1422.50	Total charge.
Less previous charge for lights and motors		415.00	
Total charge for electric furnace power		$1007.50	

$\frac{\text{1007.50—total charge}}{\text{131,000—kilowatt hours used}} = 0.77$, shows the furnace power cost to be 0.77 cent per kilowatt hour.

And if, in case 4, the plant had three times the furnace installation figured previously, and used it 24 hours a day, it would have 900 kilowatts furnace demand (1100 kilowatts total) and 430,000 kilowatt hours per month furnace energy (470,000 total). The charge would then be figured:

50 x $1.50 =		$ 75.00	
1,050 x 1.00 =		1050.00	
		$1125.00	Demand charge
2,500 x $0.02 =		50.00	
35,000 x 0.008 =		280.00	
310,000 x 0.005 =		1550.00	
122,500 x 0.004 =		490.00	
470,000	Total kilowatt hours used.	$2370.00	Energy charge
		1125.00	Demand charge
		$3495.00	Total charge
Less previous charge for lights and motors		415.00	
Total charge for electric furnace power		$3080.00	

$\frac{\text{3080.00—total charge}}{\text{450,000—kilowatt hours used}} = 0.68$, shows the electric furnace power cost to be 0.68 cent per kilowatt hour.

The conclusions from these four cases are shown in the accompanying Table II. This table illustrates the advantage of continuous operation of electric furnaces, as well as the benefit derived from large installations. The exact figures will vary in each particular case, but the ratios will remain approximately the same.

TABLE II

Figures From Different Operating Conditions

Case No.	1	2	3	4
Hours of furnace operation	9	18	24	24
Number of furnaces	1	1	1	3
Kilowatt hours per ton	335	275	250	250
Furnace, power price, cents per kilowatt hour	1.205	0.89	0.77	0.68
Cost, dollars per ton for power	4.04	2.45	1.93	1.70

After one electric furnace is in use, the installation of more is increasingly attractive up to the point where the normal production of the shop is electrically melted. However, on account of the initial cost and the interest charge, electric furnaces, as a general rule should not be provided to handle small peaks of production in excess of the normal. A fuel-fired furnace of lower initial cost should be utilized for this purpose.

Sometimes the power cost can be reduced in another way. Many central stations would be glad to improve their load factor, that is, instead of having all their generating equipment overloaded in the rush hours with their *peak load*, and almost idle from midnight to morning, they would like to keep it at all full load all the time. Such stations—and each one has a different time of the day and year for its heaviest peak loads—would be glad to sell off-peak power at a material reduction over ordinary power. That is, if the foundry will agree not to run its electric furnaces, for example, between 3 and 6 p. m. December to March, or between 4 and 6 p. m. the rest of the year, power will be supplied at any other time at a price lower than the regular schedule*. Therefore it is well to ascertain from the central station just what its power schedule will be under various conditions, since it may be possible to work out an operating schedule to fit, at a considerable saving in cost of power.

Whether it is possible to operate more than one shift per day or not, it is always important to keep operating during the entire scheduled time. The furnace should be kept actually melting metal with as short idle periods for charging and pouring as possible. Mechanical charging, where the furnace design makes it practical, and rapid pouring, preferably into a few big ladles instead of into a lot of small ones, especially when the metal has to be held in the furnace waiting for the first ladles to come back from the other end of the foundry, play a large part in enabling the furnace to do a lot of work and do it cheaply.

Mechanical charging in electric steel furnaces is termed by Styri** "an essential element in the economy of operation," and he suggests a redesign of the heroult steel furnace to permit charging it mechanically. When the ad-

*Compare Richards, J. W., and Crosby, E. L., Discussion, Trans. Am. Electrochem. Soc., Vol. 25, 1914, pp. 151, 153.

**Styri, H., The Electric Furnace in the Development of the Norwegian Iron Industry, Trans. Am. Electrochem. Soc., Vol. 32, 1917, p. 224.

TABLE I

Records Of Heats As Run And As They Might Have Been Run

Heats as Run							As They Could Have Been Run by Eliminating Delays						
Heat	Charge lbs.	Total time hours and min.	Arc on hours and min.	Idle time hours and min.	K. W. hours used	K. W. hours per 100 lbs.	Heat	Charge lbs.	Total time hours and min.	Arc on hours and min.	Idle time hours and min.	K. W. hours used	K. W. hours per 100 lbs.
1	497	2:45	2:05	40	211	*42	1	525	2:10	1:95	15	215	41
2	522	1:45	1:25	20	130	25	2	525	1:40	1:25	15	130	25
3	527	2:55	1:10	1:45**	105	20	3	525	1:25	1:10	15	105	20
4	523	1:25	1:05	20	106	20	4	525	1:20	1:05	15	100	19
5	394	1:25	1:10	15	94	25	5	525	1:20	1:05	15	100	19
							6	525	1:20	1:05	15	100	19
Total	2463	10:15	6:55	3:20	646	Av. 26	Total	3150	9:15	7:45	1:30	750	24

Average shows 520 kilowatt hours per ton.

Average shows 480 kilowatt hours per ton.

*Furnace at red heat from previous day's run.

**Delay waiting for molds.

vantages of a high rate of production are thoroughly impressed on the furnace users, the next obvious step, preheating the charge by fuel and finishing the heat in the electric furnace, will undoubtedly be tried out. Under many conditions this would be more trouble than it would be worth, but under other conditions it should show a marked saving in melting cost.

Again, the higher the rate of power input, within the limit the refractories will stand, the better because of the greater production as well as increased efficiency secured. Suppose a furnace takes 100 kilowatts and loses 35 kilowatts through shell radiation and electrode losses, then 65 kilowatts do useful work. If the same furnace is given 125 kilowatts it may lose 37½ kilowatts in shell and electrode losses, but 87½ kilowatts do useful work. The furnace will do one-third more work in a given time at the higher rate. Automatic electrode control will maintain a high input more steadily than hand control, on furnaces where either can be used, and thus tends to decrease power consumption per ton of metal melted as well as to lower labor cost.

Another source of loss in efficiency is heating the metal hotter than is necessary. Every degree of needless superheat consumes power and time. Holding the metal in the furnace waiting for molds can be done in most electric furnaces without injury to the metal, but the delays thus caused raise power consumption, lower output, and increase melting costs.

The importance of eliminating all possible sources of delay can be best illustrated by an actual example. Take the run on a small Rennerfelt furnace on red brass illustrated in Table I. Any type, make, or size furnace on any alloy would show the same general condition. The results show the elimination of delays gives a 25 per cent increase in output in an hour less time, at 40 kilowatt hours less per ton. As St. John* points out, an accurate furnace record, or log, is of great value in showing the amount of avoidable delay and its causes.

For a furnace to stand idle, as when waiting for a charge, or to be kept holding the metal while waiting for molds or for the ladle crane, cuts down its production. Such delays will occur, but the more often they occur, the farther will be the furnace performance from its maximum. There is, of course, a point where insistence on purely furnace efficiency, as differentiated from the total efficiency of the shop, will reduce its real efficiency, measured in dollars and cents. But, because the cost of electric power and the interest charges on a large investment, melting costs in electric furnaces show greater savings between careful and careless operation than do fuel-fired furnaces. Therefore electric melting will repay careful supervision to keep it near the standard. Perhaps the most potent method of creating the proper impression in the shop and making anything that would delay the furnace unpopular, is to pay the furnace tender a bonus for production which is large enough to make him anxious to earn it.

Records should be kept of furnace operations, so that any inefficiency is readily noticed. Keeping such records is made possible by providing each furnace with its own kilowatt-hour meter, instead of merely having one such meter for all the power used in the plant. These meters may not be needed on the induction furnace, which has so steady a load that heats may be brought out on a time schedule. Other furnaces are best run on a kilowatt-hour schedule. After a few test runs one can make out a definite schedule of kilowatt hours needed on each heat for any particular furnace, with any particular alloy, definite proportion of ingot, scrap, and borings, and any given weight of charge. In 9-hour operation the kilowatt hours per heat will be higher in the morning and approach or reach a lower constant figure at the end of the day.

By adhering to such a schedule and running on kilowatt-hour input instead of on a time schedule at a supposedly constant but actually variable kilowatt input, the heats can be brought out with astonishing regularity as to temperature. The kilowatt-hour meter is as important as the speedometer on a motor car or truck. Not all furnace makers supply them, but each furnace should have one.

The efficient operation of an electric furnace is in many ways much like that of a motor truck. The more hours a day it is used, the fewer the stops, and the more heavily loaded, up to its capacity, the lower the cost per ton mile for the truck and per ton output for the furnace. If gasoline were distinctly cheaper when bought in large quantities, as power is, the analogy could be carried still farther.

Since conditions for most rapid production in electric furnaces are the conditions for lowest melting cost, it is plain that it is the larger firms having the most need for production, that are in the best position to utilize the advantages of the electric furnace as well as to finance their high first cost.

However, the many successful installations in rather small foundries indicate that the big companies are not the only ones who can save money by electric melting. The small firm that has power available at not too high a cost can often effect a saving if it chooses a suitable type of electric furnace, installs it properly, and operates it at its maximum efficiency. However, if the furnace is not operated properly it can in a good many cases, quite readily lose money. Careless operation may easily increase the total melting cost in a small furnace by half over what the furnace maker can demonstrate the cost can be brought to under ideal operating conditions.

Careful operation is important even in the largest shops, but there is usually so much leeway between melting costs in fuel-fired and electric furnaces in such shops that the cost sheets still look well compared with the old ones. In the small jobbing shop that is on the border line as to cost of melting by fuel and by electricity, careless operation is likely to turn a possible saving into an actual loss.

This series of articles has so far been based on electric brass furnace conditions as they are today. The next and last article will consider what those conditions are likely to be in the future.

*St. John, H. M., Commercial Testing of Metallurgical Electric Furnaces, Chem. and Met. Eng., Vol. 21, 1919, p. 381.

Fluorspar Production

The United States geological survey reports, from figures received from the principal producers of fluorspar, that the total shipments from domestic mines in 1919 amounted to approximately 122,000 short tons valued at $3,102,000, as compared with 263,817 tons valued at $5,465,481 in 1918. The shipments of gravel spar, the grade used principally for flux in the manufacture of open-hearth steel, amounted in 1919 to about 110,000 short tons as compared with 236,121 tons in 1918. The import of fluorspar into the United States in 1919 were 6943 short tons as compared with 12,572 tons in 1918.

Plans to Build Foundry

The Melrose Park grounds of Providence, R. I., have been purchased for the Whitins Machine Works of Whitinsville, Mass., and plans are being considered for the erection of a series of buildings and the establishing of a large modern foundry plant.

S. H. Cleland recently was appointed eastern sales manager with temporary offices at 15 East Fortieth street, New York, for the National Engineering Co., Chicago, manufacturer of foundry equipment including the Simpson sand mixer.

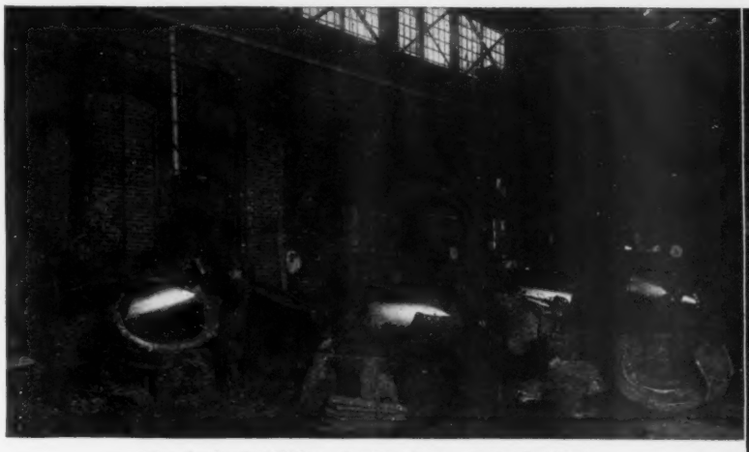


Fig. 1—An installation of swing frame grinding machines

Grinding Manganese Steel

BY R. M. JOHNSON

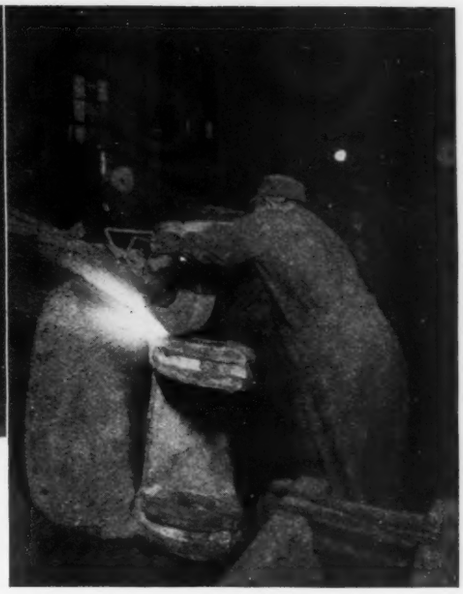


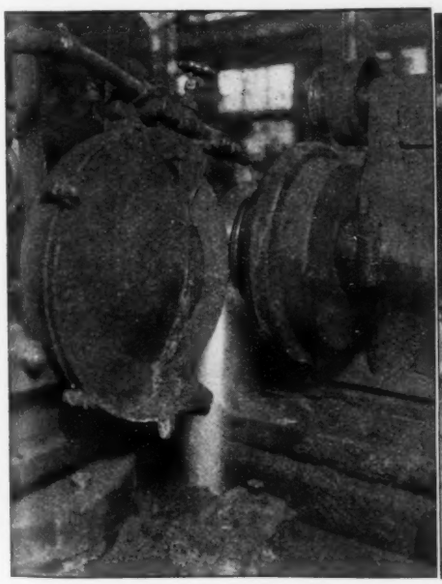
Fig. 2—Close-up showing the operator snagging a bucket

ALLOY steels are of unusual interest, not only because of the large number of different combinations of properties that can be obtained, but also because of the increased efficiency of these comparatively new steels. Carbon steel is really an alloy steel, but when we refer to this class we mean steel to which has been added some of the less common metals such as tungsten, vanadium, molybdenum, nickel, manganese, and chromium. Possibly not the most important, but surely one of the most interesting of these, is manganese steel containing manganese in quantities from 12 to 14 per cent. The steel, although discovered by Robert Hadfield in 1886, did not come into prominence until about 25 years ago. And it was even later when its great commercial value was realized. Up to the time it was discovered, all metals that were hard enough to resist abrasive wear were so brittle that they could not be used for many parts. Chilled iron is very hard, but very brittle and comparatively weak. Hardened tool steel is stiff and easily broken under shock. Manganese steel is hard and also very tough.

This property of toughness with hardness is obtained only after the manganese steel castings are heat-treated. When cast and allowed to cool slowly the castings are hard, but also very brittle. After removing from the molds the castings are heated and quenched in cold water. The resulting casting is hard, tough, and so malleable that it can be drawn into wire, rolled, and forged. When in the brittle unannealed condition, the risers and sprues can be broken off. After annealing, the casting can not be commercially machined with any steel tool now known, but must be ground. If a keyway is to be cut or a hole tapped, soft steel inserts are set in the molds and the metal cast around them.

The uses for manganese steel are practically without limit. In general

From a recent issue of *Grits and Grinds*, published by Norton Co., Worcester, Mass.



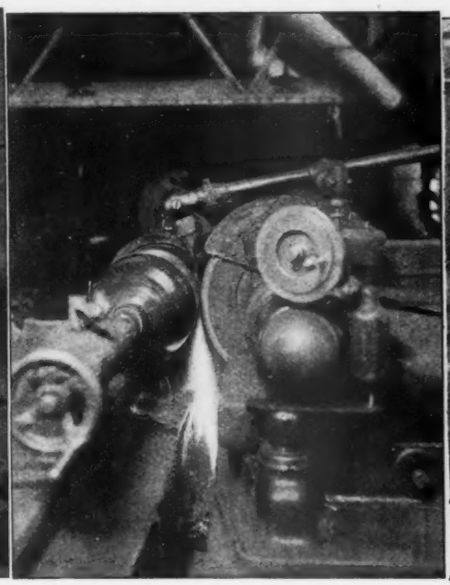


FIG. 3—FINISHING THE PERIPHERY OF A CRANE WHEEL ON A CYLINDRICAL GRINDING MACHINE FIG. 4—GRINDING PIPE BALLS—A VERY SEVERE OPERATION FIG. 5—GRINDING A SIDE LINER 8 FEET 7½ INCHES DIAMETER FOR A CENTRIFUGAL PUMP

FIG. 6—STATIONARY GRINDING STANDS PROVIDED WITH ADEQUATE SAFETY FEATURES FIG. 7—SURFACING CRUSHER SEGMENTS ON A SURFACE GRINDING MACHINE OF THE PLANER TYPE

where moving parts are constantly exposed to gritty dust, manganese steel castings give excellent service. Possibly an enumeration of some types of machinery in the construction of which this still is used will be interesting; crushing and pulverizing machinery for ores, coal, slag, and cement; clay working machinery; emery mill rolls; buckets, chain, and sprockets for bucket elevators; corrugated rolls, segments, gears, and pinions of coal crushers for wire ropeways; wearing parts of steam shovels, dredges, and ditching machinery; and centrifugal pumps. Manganese steel is also used for crossings, frogs, switches, and guard rails; for tractor links and sprockets; for gears and pinions commonly used in steel mills; and for safes.

A typical analysis for manganese steel is: Carbon, 1.25 per cent; silicon, 0.3 per cent; manganese, 12.5 per cent; sulphur, 0.02 per cent and less; phosphorus, 0.08 per cent.

In connection with the use of manganese steel sheaves an important property is brought to light. Cast-iron sheaves require frequent renewal. Particles of grit become imbedded in the groove, metal particles work into the rope, scoring the groove and in time cutting the rope. It is claimed that manganese steel sheaves wear smooth and as a result the ropes sometimes last 100 per cent longer. Because of the increased strength the sheaves many times can be made 30 to 50 per cent lighter in weight.

Castings Offer Severe Tests

Grinding manganese steel, either snagging or semiprecision is a very severe operation. Chisels cannot be used for removing the heavy fins and burrs from the rough castings. They must be broken off with sledge-hammers before annealing or cut off with an oxyhydrogen or oxyacetylene torch. Whichever method is used, the castings are very rough and jagged when they come to the cleaning room.

Fig. 1 shows an installation of swing frame grinding machines. Attention is called especially to the excellent construction of the machines, which are rigid, have plenty of power and are suspended from one point giving universal movement. The work shown is the rough snagging of gold dredge buckets, nose pieces for these buckets and rock crusher parts. Fig. 2 shows a close-up view of one of the swing frame machines snagging a gold dredge bucket.

Fig 8 shows a ½ x ¾ x 9-inch wheel mounted on a flexible shaft machine, snagging a crane wheel.

For snagging operations such as these, the grinding wheel must be free cutting. At best, considering heat is developed when manganese steel is ground, slow cutting wheels increase heat and increase the possibility of breakage. Hard wheels heat and cut slowly; soft wheels are cool cutting, grind rapidly, and of course wear faster than the hard

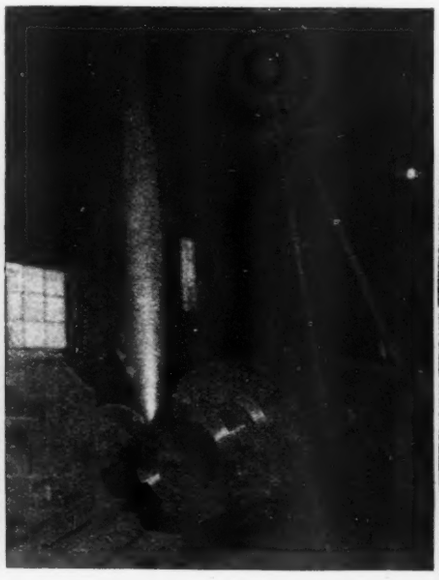


FIG. 8—WHEEL MOUNTED ON A FLEXIBLE SHAFT SNAGGING A CRANE WHEEL FIG. 9—SPECIAL LATHE FOR GRINDING SAFE DOORS FIG. 10—SPECIALLY DESIGNED MACHINE SHOWN IN THE ILLUSTRATION GRINDING THE ENDS OF BALL MILL PLATES USED IN A CEMENT-GRINDING MACHINE

wheels. There is a grain and grade which gives maximum results when considered from all angles.

A cylindrical grinding machine used for finishing the periphery of crane wheels is shown in Fig. 3. An 8 x 2 x 18-inch wheel running at 6500 surface speed per minute is used. The work revolves at 32 revolutions per minute, a surface speed of 100 feet per minute. A fillet is ground on both sides of the tread, the wheel being fed straight in.

Fig. 4 shows another cylindrical operation, grinding pipe balls. The wheel speed is 6500 surface speed per minute, work speed 200 surface speed per minute, feed 0.010 inch, table traverse 108 inches per minute. The part ground is 11 inches in diameter by 6 inches long. This operation is very severe on the grinding wheel; it must cut rapidly or the wheel wear is excessive. A 2½-inch wheel is used.

A special lathe which can be rigged for all kinds of work is shown in Fig. 5. The picture shows an 8-foot 7⅛-inch diameter suction side liner for a centrifugal pump being ground with 1¾ x 2 x 14-inch vitrified wheel. A work speed of 300 feet per minute is used.

Fig. 10 is a specially designed machine for surface grinding and is called a pit grinding machine. It mounts four 1½x 1¾ x 10-inch wheels. The picture shows the machine being used for grinding the ends of ball mill plates used in a cement grinding machine. The traverse is 144 inches per minute.

Another surface grinding machine, a planer type, is shown in Fig. 7. It is being used here for surfacing crusher segments. The wheels are 1½ x 2 x 10-inch. The table traverse is 240 inches per minute.

The manufacture of manganese steel safes is an interesting process. The rough castings are snagged in the cleaning room. The door hole in the safe is ground internally on a lathe. Fig. 9 shows a special lathe used for cylindrically grinding the safe doors. The work speed is about 20 feet per minute. After the door and the door hole have been ground to practically the same size, abrasive grain mixed with oil is placed on the bearing surface and the door lapped in until the safe is absolutely air tight.

Open Sand for Making Gear Teeth

Question:—We are making fairly heavy gear wheels up to 12 inches in diameter and experience considerable trouble on account of the sand burning into the teeh. We will appreciate any information you can give us on how to avoid this trouble, the proper kind of sand to use, the best way to ram the teeth and the most efficient equipment for making these gears in quantity production.

Answer:—Mix coal dust with your facing sand in the proportion of one part of coal dust to eight parts of sand; that will cause the sand to peel off the teeth and leave them clean. A medium coarse grade of sand is necessary to make satisfactory gear wheels. If fine sand is used it will cause trouble in two ways. If it is rammed hard it will cause the teeth to buckle and scab, and if it is not rammed hard enough the teeth on the casting will be swelled out of shape. The best method of ramming gear teeth is to throw the facing sand into the teeth by hand. Lay the pattern on the board or plate and, before putting on the drag flask, secure a shovelful of facing sand which has been passed through a No. 8 riddle. Take one handful of this sand at a time and keep throwing it against the teeth until all of them are filled. The flask may then be put on and rammed up in the usual way. Whether you should adopt a power or hand-ramming machine would depend on your anticipated tonnage. Any type of stripping plate machine would answer your requirements.

Survey Present Molding Sand Figures

The work done by the United States geological survey in connection with sand and gravel is not confined to the tabulation and publication of the statistics of production. Information concerning these products is constantly being sought and compiled and is freely given to any inquirer. An engineer in New York may want a grade of sand that is especially fitted for some particular work there or elsewhere and may ask what source of supply is nearest to his project. The survey promptly puts him in touch with the firm or firms that can best supply him sand in the quantity and of the quality he desires for his particular work.

Reports received by the United States geological survey from 2800 producers show that 61,824,426 short tons (of 2000 pounds) of sand and gravel were produced in 1918. The importation of some special grades of molding sand, such as the French sand for making fine bronze castings and of refractory sands from England for lining certain iron furnaces, is due to the difficulty of making molders and foundrymen believe that the foreign sands with which they are familiar are no better than the sands which are found in different parts of America.

The output of six states which produced 85 per cent of all the domestic molding sand dug in 1918 is given in the accompanying table.

During 1918 the steel mills of the country were busy on war orders and a large number of foundries were working at top speed. For this probably more than for any other reason there was a heavy demand for molding sand. There was an increase of 5 per cent in the production of sand of this class over that of 1917, and the price per ton received averaged 13 per cent higher. The output was 4,910,178 short tons, valued at $5,121,865, as compared with 4,660,968 tons, valued at $4,303,809 in 1917.

Approximately 60,196,000 short tons of sand and gravel of all grades was sold in the United States in 1919, according to preliminary estimates made by L. M. Beach, of the survey.

This quantity represents a decrease below that sold in 1918 of about 1,628,000 tons. The value in 1919, however, was $37,819,000, as compared with $37,927,079 in 1918, which shows that the average price had increased. The trend in sand production is shown in the following summary covering five years:

Year	Molding Sand Quantity (short tons)	Value
1915	3,585,746	$2,123,203
1916	4,662,649	3,219,839
1917	4,660,968	4,303,809
1918	4,910,178	5,121,865
1919a	3,715,000	3,510,000

Producers report that the demand for this material in 1919 was heavy but that the production was curtailed on account of car shortage.

Molding Sand Production In 1918

State	1917 Quantity (short tons)	1917 Value	1917 Average price per ton	1918 Quantity (short tons)	1918 Value	1918 Average price per ton
Pennsylvania	640,450	$ 696,734	$1.09	1,158,715	$ 953,886	$0.82
Illinois	703,208	412,626	.59	885,617	658,205	.74
Ohio	999,974	1,218,217	1.22	857,481	1,493,541	1.74
New York	650,,427	808,550	1.24	519,681	770,512	1.48
New Jersey	611,916	651,279	1.06	442,007	626,637	1.42
Indiana	287,483	111,732	.39	298,934	135,605	.45

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Contents

	Page
Continuous Shop Is Highly Efficient	625
Under New Management	630
Fabricating Steel Foundry Flasks	631
Securing Low-Carbon Cast Iron	634
Irons for Diesel Engine Castings	635
Anneal Malleable in Tunnel Kiln	638
How Spur Gear Patterns Are Made—I	645
Organize Steel Casting Company	648
Consolidated Interests to Build Foundry	648
Pointers on Casting Monel Metal	649
Cast-Iron Blocks Conserve Cupola Lining	651
Bill Enters the Ring with the Foundry Jinx	652
How and Why in Brass Founding	654
Casting Nickel Silver	654
Nickel Castings Show Pin Holes	654
Care is Necessary with Phosphor Bronze	654
Difficulties with Nickel Alloy Castings	655
Crucible Making Deemed Impractical in Shop	655
Metal Like Aluminum	655
Electrical Melting of Alloys—XII	656
Fluorspar Production	658
Plans to Build Foundry	658
Grinding Manganese Steel	659
Open Sand for Making Gear Teeth	661
Survey Present Molding Sand Figures	661
Making the Shop Fit the Product	662
Trade Outlook in the Foundry Industry	663
Comings and Goings of Foundrymen	664
Will Hold Fall Meeting	664
Change Meeting Dates of Chicago Club	664
Choose Name for Societies in Affiliation	664
Organize Foundry	664
Obituary	665
What the Foundries Are Doing	665
New Trade Publications	666

Making the Shop Fit the Product

IN THE ordinary manufacturing plant the foundry occupies the same relative position that the kitchen commands in the home, and it must be conceded that it usually is considered by the owners in much the same light that the average man thinks of that essential domestic department. He regards it a necessity to be tolerated, but something that does not require elaborate furnishings or modern conveniences. Furthermore, the foundry, like the kitchen, is situated as far as possible from the front door with all the intervening doors carefully closed so that it may not contaminate the atmosphere of the other rooms. Its existence is admitted but politely ignored as far as possible.

The owners of a business are constantly on the alert to discover and apply new and improved methods in finishing their manufactured product, in developing and expanding their business according to modern standards, and in adopting present day publicity ideas. They take a commendable pride in keeping their office furniture and routine office work abreast of the times. Rarely do they hesitate in scrapping obsolete machinery or in building additions to their plant to facilitate the production made possible by improved mechanical equipment and methods.

The office and machine shop, corresponding to the parlor and living room, are furnished and equipped according to the style of the times, and in conformity with the prestige of the owners; but the foundry—the kitchen—is *only* the foundry and so long as a sufficient quantity of castings emerge from its mysterious depths to keep the plant running, no one seems to care. Whether the adoption of modern methods and appliances would not show gratifying results in reduced costs, increased production or both is not considered in the average shop.

Just as the location and equipment of the modern kitchen are receiving the attention they deserve, so also are manufacturers generally taking a more pronounced interest in the foundry. The same interest is evidenced in both the construction and equipment of the modern shop, and an effort is being made in most new undertakings to place the foundry on a par with the remainder of the plant.

The great strides made by the foundry industry in recent years; the marked advantages enjoyed by the large number of foundries designed and built for the specific manufacture of a definite product, as reflected in the volume of business and in their cost sheets, has influenced many manufacturers to consider seriously the erection of new foundries, designed, built and equipped in a special manner to suit their particular requirements. While it is true that foundries all are alike in their general characteristics, still there are so many details in connection with each of these operations, depending on the shape, size and other characteristics of the desired casting that a type of shop and equipment eminently suitable for one class of castings would be totally unsuitable for another. It is therefore essential that the question be given careful consideration to secure the type of building and equipment which is best adapted to the particular work. Two points in particular, constantly should be kept in mind when planning either an entire new building and installation, or remodeling and rearranging the equipment in one already existing. The first point is to provide a building adequately heated, lighted and ventilated and the other is to so plan the work that there will be no duplication.

Trade Outlook in the Foundry Industry

THE cloud of prospective advances in freight rates has a silver lining for the foundryman who hopes the increase in revenue received by the railroads will enable them to provide sufficient rolling stock adequately to meet the needs of the country's industries. Almost anything which promises to give adequate shipping facilities would be welcome to the foundries pressed as they are for materials. Another slant to the rate raise is the ultimate casting business to be received by the foundries in supplying castings for new equipment.

Prices Advance

However, there is the other side of increased cost of materials. Pig iron is heavily dependent on carriers in its manufacture and the cost of its production will be materially increased by higher freight rates. It also would seem that the southern iron would be at a slight disadvantage from the change, as the hauls on these grades on the average are longer than the hauls on northern irons. Whatever the future developments may show, the present tendency is for an increase in the price of pig iron in nearly all centers. In the South some producers continue to offer No. 2 pig iron at the former price of $42 for delivery the last quarter of this year and the first quarter of next. However, the majority of the producers are quoting $44 for this iron. Iron is being stocked at the furnaces in this district owing to lack of facilities, but every effort is being made to maintain production. The eastern pig iron scarcity shows no signs of easing and most furnaces are fully booked. Current inquiry includes smaller lots for this delivery and some for first and even second quarter. Malleable demand is strong in Chicago but round tonnages cannot be covered in that market and must be sought from Ohio producers. A sale of 1000 tons from an Ohio furnace has been closed for last half delivery at $48, furnace, which brings it to about $51, Chicago, with the added haulage charge.

Prices of Raw Materials for Foundry Use

CORRECTED TO AUG. 6

Iron		Scrap	
No. 2 Foundry, Valley	$46.00 to 47.00	Heavy melting steel, Valley	$25.50 to 26.25
No. 2 Southern, Birmingham	42.00 to 44.00	Heavy melting steel, Pittsburgh	27.00 to 27.50
No. 2 Foundry, Chicago	46.00	Heavy melting steel, Chicago	24.50 to 25.00
No. 2 Foundry, Philadelphia	48.10 to 49.10	Stove plate, Chicago	31.50 to 32.00
Basic, Valley	46.50	No. 1 cast, Chicago	42.00 to 42.50
Malleable, Chicago	46.50	No. 1 cast, Philadelphia	38.00 to 42.00
Malleable, Buffalo	46.25	No. 1 cast, Birmingham	32.00 to 35.00
Coke		Car wheels, iron, Pittsburgh	42.00 to 43.00
Connellsville foundry coke	$18.50 to 19.00	Car wheels, iron Chicago	37.50 to 38.00
Wise county foundry coke	19.50 to 21.00	Railroad malleable, Chicago	32.00 to 32.50
		Agricultural malleable, Chicago	31.50 to 32.00

Production Increases

Production of pig iron for July showed an improvement of only 14,000 tons over the June output. This small increase in the total still permits a drop from the June rate of production. The total output for July was 3,060,626 gross tons, while the tonnage for June was 3,046,623 gross tons. The July production represents 98,729 tons per day, or a loss of 2824 tons from the June average of 101,553 tons. Merchant stacks made 782,596 tons compared with 769,236 tons in June, a gain of 13,360 tons. The daily average was thus 25,245 tons, which is short of the June average of 25,641 tons by 396 tons per day. Production of beehive coke increased by 18,000 tons during the week ending July 24. The total output of coke, estimated on the basis of railroad shipments was 381,000 net tons against 363,000 net tons for the week of July 17. This increased production was not felt in the consuming centers. Pittsburgh reports a shortage of coke. Quotations on prompt foundry coke hold around $19.50, while even higher prices have been paid in some instances. The coke market in Cincinnati is irregular as a result of continued shortage with a heavy buying demand. Most of the coke sold recently at $21. Increased cost of coal is bringing up the price of by-product coke in the Chicago district. A recent advance of $1 per ton seems likely to followed by another increase in the near future as the cost of production is forced upward. At Birmingham foundry coke is quoted at $12.50, although sales have been made at $15. Coal car supplies at the mines are slowly increasing and shipments grow. The car situation for materials other than coal has been helped by the action of the interstate commerce commission in amending service order No. 9 so that the phrase *coal cars* is to include flat bottom gondola cars with sides less than 38 inches in height. It is estimated that this change will release 15,000 cars for the iron and steel trade. The increase in cars promised to foundry centers will be of great help in many districts in which the call for castings is still strong. However, in the Michigan and northern Ohio district the demand for castings is markedly decreased by the reduction in output of automobiles. A slump in the foundry business also is felt in the Philadelphia territory where a large percentage of the castings made are for the shipbuilding industry. The work at the shipyards has fallen off considerably of late, at least, the number of new vessels being started is much smaller than it has been owing to the completion of government contracts and the lack of private initiative. This decrease in shipbuilding not only is felt in foundries about Philadelphia but it also affects foundries in different parts of the country which have been making marine engine castings. So far little business has come to the foundries from orders for railroad equipment.

Although the ferrous metals are little affected by the recent stir-up in Europe, the nonferrous industry is considerably disturbed by the international situation. This is felt mostly in uncertainty in future price developments. Tin fluctuated widely with the variations in exchange, but the other metals held steady. The other controlling influence in the nonferrous foundry industry is the slowing of the automobile business which is being felt. Prices of nonferrous metals based on New York quotations of Aug. 5, follow: Copper, 18.12½c to 18.25c; lead, 8.50c; Straits tin, 49.50c to 49.75c; antimony, 7.25c; aluminum No. 12 alloy, producers' price, 32.00c, and open market, 29.00c to 30.50c. Zinc is quoted at 7.80c to 7.85c, St. Louis.

Comings and Goings of Foundrymen

FRED A. BARENDT, who succeeded James A. Murphy as foundry superintendent at the plant of Owens, Hooven, Rentschler Co., Hamilton, O., has been with the company in the capacity of general foundry foreman for several years. Previous to joining the Hamilton firm he had a wide experience in the marine engine field. He served his time with the American Shipbuilding Co., Cleveland, where he worked for more than 10 years under such competent marine men as the late G. S. Stoney, Elias Thomas and Hugh McKenzie. He was foreman of the Globe Foundry Co., a subsidiary of the American Shipbuilding Co., Cleveland, before accepting his position in Hamilton, O.

Edward J. Mulvaney has accepted a position with the Standard Engineering Works, Ellwood City, Pa.

Arthur Corbeille has assumed the management of the W. L. McCullough Foundry Co., of Ypsilanti, Mich.

P. H. Davis has resigned after 30 years service as superintendent for the Moline Malleable Iron Co., St. Charles, Ill.

E. A. Walcher has been made works manager of the American Steel Foundries plant at Granite City, Ill., succeeding W. C. Hamilton.

C. M. Campbell who until recently was metallurgist for the West Steel Castings Co., Cleveland, has been made superintendent for the Pioneer Alloy Products Co., of that city.

Charles H. McKnight, president of the Carbon Steel Co. and the Pittsburgh Iron & Steel Foundries Co., both of Pittsburgh, left recently for a two months' trip to Europe.

Frank E. Rentz, formerly superintendent of A. Allan & Co., Harrison, N. J., has been made superintendent for Sheeler-Hemsher Co., Philadelphia, maker of special alloys.

Gilbert Murray, formerly connected with the Hill Pump Works and the Mid-West Engine Co., has started on his new duties as general superintendent of the Anderson Foundry & Machine Works, Anderson, Ind.

Albert W. Walker, foreman of the foundry department of the Howard & Bulough American Machine Co., Pawtucket, R. I., has recently resigned his position to accept a similar position in Elmira, N. Y.

C. B. Fulton, for seven years with the Fawcus Machine Co., Pittsburgh, has been made general superintendent of the Aetna Foundry & Machine Co. Warren, O. John H. Rose, formerly in the engineering departments of the Youngstown Sheet & Tube Co., and the Republic Iron & Steel Co., Youngstown, has been made chief engineer.

A. W. Vale, who until recently has been foreman of the pattern shop of the R. V. & W. Bolt & Nut Co., Port Chester, N. Y., has accepted a position with the Bethlehem Shipbuilding Corp., Elizabeth Port, N. J.

A. Robertson, formerly works manager at the Sharon, Pa., plant of the American Steel Foundries has been transferred to Alliance, O., where he will be works manager of another plant of the same company. Mr. Robertson is succeeded by Marshall Post. M. E. First, who was works manager at Alliance, has resigned.

W. A. Toothill has been appointed sales representative for the Dayton, O., territory for the Quigley Furnace Specialties Co., New York, manufacturer of steel and alloy pots and boxes. Mr. Toothill was for some years metallurgist with the International Motors Co. at the Plainfield and New Brunswick, N. J., plants of that company.

Will Hold Fall Meeting

The fall meeting of the British Institute of Metals will be held at Barrow-in-Furness, England, Sept. 15 and 16. An extensive program of papers dealing with nonferrous metals has been prepared. The program includes an official reception by the mayor, together with visits to a number of interesting iron and steel works including the following: Messrs. Vickers, Ltd.; the Barrow Hematite Steel Works; the Barrow Paper Mills; Hodbarrow Mines; Millom & Askam Hematite Iron Works; North Lonsdale Iron & Steel Co.

Change Meeting Dates of Chicago Club

Meetings of the Chicago Foundrymen's club during September and October will be deferred one week, to the third Saturday evening of each month, instead of the second Saturday, resuming the regular schedule the second Saturday of November. The new dates will be Sept. 18 and Oct. 16.

Choose Name for Societies in Affiliation

Considerations which influenced the naming of the Federated American Engineering societies are reviewed in a bulletin recently issued by the joint conference committee of the national technical organization. According to the statement, the purpose was to secure a short title that could readily be used. The committee decided that the name of the organization should be indicative of its character, based on the fundamental resolution of the organizing conference, that it should consist of societies and not of individual members. The words "association," "confederation," "federation," and others were suggested and considered and all were rejected and finally as a compromise the word "federated" was unanimously agreed upon. As other countries are looking with interest on this movement with the probability that there will be similar organizations formed in those countries, it was felt desirable that some distinctive name should be given the organization in this country, and so the word "American" was adopted. It was thought undesirable to use as long a name as "Engineering and Allied Technical Societies," especially in view of the fact that engineering as defined in the preamble of the constitution is an all inclusive word, and it was, therefore, decided to use only the word "engineering" in the title. Hence the name "Federated American Engineering Societies."

Organize Foundry

Capitalized at $400,000, the Decatur Casting Co., with headquarters at Hamilton, O., recently was organized to engage in the manufacture of gray-iron castings, which are now being produced in a plant which the company has purchased at Decatur, Ind. Officers of the company are: President, G. S. Rentschler Sr.; vice president, G. A. Rentschler Jr.; secretary and treasurer, H. A. Rentschler, and general manager, D. McDaniel.

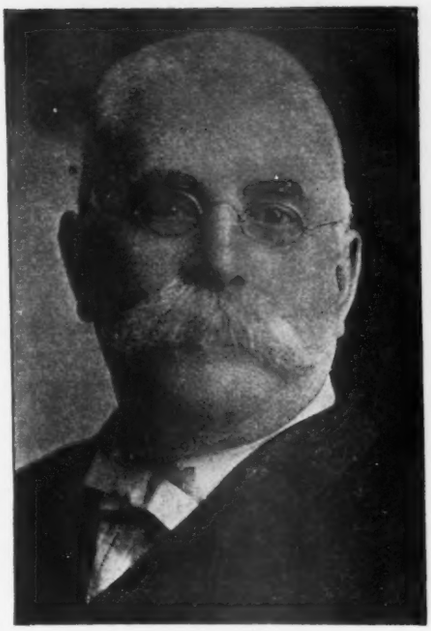
The Service Casting Co. recently has been organized at Blanchester, O., by R. B. Huyett and Chas. N. Secrist, to specialize in small gray-iron castings. The foundry has been in operation since Feb. 1, 1920, doing contract work.

Obituary

Erastus Kies, who for many years was prominent in the malleable iron industry at Erie, Pa., died at the home of his daughter in Erie, July 18, at the age of 81. Mr. Kies first entered the malleable iron industry in the early sixties at Toledo and Canton, O., and in 1871 became associated with the Jarecki Mfg. Co., Erie. When the Erie Malleable Iron Co. was organized in 1880, Mr. Kies was appointed superintendent. He retired from active business in 1913.

William A. Schreiber, president, the L. Schreiber & Sons Co., Cincinnati, died recently at his home in that city.

Arthur Jerome Eddy, organizer of the American Steel Foundry Corp., National Turbine Co., the American Linseed Oil Co., and author of Eddy on *Trusts and Combinations*, recently died in Chicago.



ERASTUS KIES

The use of natural gas for the production of high temperatures is never satisfactory without regeneration, and most natural gas users fail to regenerate it but work with cold gas and cold air. One difficulty in making proper regenerators for natural gas is that tremendous volumes of air are required for one volume of gas; in the case of producer gas about equal volumes of gas and air are used, but for natural gas fully six volumes of air to one volume of gas must be employed.

One method of salvaging the tin from tin plate scrap consists of electrolyzing the scrap in a soda bath, from which spongy tin is thrown down on an iron cathode. The tin is scraped from the cathodes, washed, dried, melted and cast into ingots.

What the Foundries Are Doing

Activities of the Iron Steel and Brass Shops

The Randall Foundry Co., Michigan City, Ind., plans to erect a foundry, 90 x 100 feet.

The Oil City Brass Works, Beaumont, Tex., is planning the erection of a new plant.

The Fisk & Jencks Foundry Co., Geneva, Ill., has purchased the buildings now occupied by H. B. Fargo.

The capital stock of the Hershey Machine & Foundry Co., Lancaster, Pa., recently was increased from $30,000 to $200,000.

Bids have been taken by the Wanner Malleable Iron Co., Hammond, Ind., for the erection of a building, 40 x 60 feet.

The Superior Steel Castings Co., Benton Harbor, Mich., is constructing a malleable iron foundry, 200 x 300 feet.

The capital stock of the Lynchburg Foundry Co., Lynchburg, Va., has been increased from $915,000 to $1,515,000.

The Fritzell Brass Foundry Co. recently purchased the plant of the International Leather & Belting Co., New London, Conn.

The Buckley Foundry Co., Springfield, Mass., has completed plans for the erection of a foundry, 85 x 100 feet.

The Liberty Foundry Co, 1831 Center Line road, Detroit, shortly will start on the erection of an addition to its foundry, 75 x 150 feet.

Gaines Bros., Newport, R. I., metal wokers, have purchased a site of 15,000 square feet, on which they will erect an iron foundry.

The Pioneer Brass Works, Indianapolis, J. W. Peal, manager, will build a foundry, 150 x 181 feet.

The Atlas Foundry Co., 206 Colt street, Irvington, N. J., plans the erection of an addition to its plant, 60 x 60 feet.

The Fischer-Sweeney Bronze Co., 1301 Grand street, Hoboken, N. J., has increased its capital stock from $100,000 to $200,000.

Erection of an addition to its iron foundry, to be 55 x 100 feet, is being planned by the Davitt Foundry Co., Liberty street, Springefild, Mass.

The Pittsburgh Malleable Iron Co., 34 Smallman street, Pittsburgh, has acquired a plant site, 120 x 160 feet.

The Hodes-Zink Co., Fremont, O., manufacturer of automobile castings, has acquired a site on which it plans the erection of a plant, 105 x 130 feet.

The Charles D. Hevenor Co., Buffalo, has been incorporated with a capital stock of $100,000, to manufacture machinery, castings, etc., by H. M. and J. H. Frotheringham and L. Tilden.

The New Haven Stove Repair Co., New Haven, Conn., has awarded a contract for the erection of a new plant, 24 x 100 feet, with an extension, 12 x 24 feet.

Foundation work has been completed and all the electrical equipment has been purchased for the installation of an electric furnace at the plant of the Cincinnati Steel Casting Co., Cincinnati.

The Carroll Castings Co., East Chicago, Ind., has purchased a tract as a site on which to build a new plant. The company, which is capitalized at $25,000, will manufacture gray iron castings.

The Modern Foundry & Machine Co., Minneapolis, L. J. Bedard, manager, 3132 Snelling avenue, is building a foundry and machine shop, 74 x 140 feet.

The Southern Equipment Co., Laurel, Miss., capitalized at $10,000, has been chartered to manufacture foundry products, by B. J. Coffman and J. M. Calhoun.

The Richmond Hill Foundry Co., Brooklyn, N. Y., has been organized by E. J. A. Williams and J. M. O'Shea, 189 Montague street, Brooklyn, to engage in the manufacture of iron and steel castings, etc.

The buildings formerly operated by the Rhode Island Perkins Horse Shoe Co., Valley Falls, R. I., are being altered for an iron foundry for the Chelsea Iron Works Co.

The Kenosha Foundry Co., Kenosha, Wis., plans to construct a foundry, 50 x 150 feet.

The American Carbonic Machinery Co., Grand Rapids, Wis., manufacturer of ice machines, etc., plans the erection of a number of plant additions, including a pattern storage building.

The Elkhart Foundry & Machine Co., Elkhart, Ind., contemplates the erection of an addition to its plant.

The Bernert Mfg. Co., 489 Twelfth street, Milwaukee, has awarded contracts for the erection of a new foundry and machine shop, 60 x 160 feet, and 40 x 60 feet.

The Albion Foundry & Machine Co., Albion, Mich., has been incorporated with a capital stock of $100,000, by Arthur C. Hudnutt and others, to take over the foundry of the Union Steel Products Co.

The Worthington Pump & Machinery Corp. has started work on the construction of a new pattern shop at its plant in Cudahy, a suburb of Milwaukee. John D. Bird is general manager.

The P. D. Piston Ring Co., Eau Claire, Wis., is a new corporation, organized by C. M. Pratt, Edward L. Ross and Joseph C. Culver, to engage in the manufacture of piston rings, etc.

The Aluminum Manufactures, Inc., Cleveland, has purchased a 10-acre site at Marysville, Mich., on which it plans to build a plant for the manufacture of aluminum castings and drop forgings.

Fire recently damaged the plant of the Murphy Foundry Co., Beaver Falls, Pa., manufacturer of iron and steel castings. The plant will be rebuilt.

The Industrial Production Engineering Co., Dayton, O., wood and metal pattern maker, plans to increase its capital stock from $10,000 to $25,000, to finance the enlarging of its plant.

An addition is being erected to the foundry of the Buckeye Foundry & Mfg. Co., Overpeck, O., which it is expected will be ready for occupancy shortly.

A company is being organized at Benton Harbor, Mich., by O. R. and W. E. Allerton, of the Allerton Pattern Works, Benton Harbor, which will engage in the foundry business.

The Walker & Pratt Co., 33 Union street, Boston, manufacturer of boilers, stoves, etc., with a

plant at Watertown, Mass., is having plans prepared for the erection of a foundry, 200 x 230 feet.

Charles McMurphy, formerly connected with the Laconia Car Co., Laconia, N. H., with a number of associates is erecting a foundry at Concord Junction, Mass.

The Fairbanks Co., 4-10 Glenwood avenue, Binghamton, N. Y., manufacturer of iron and brass valves and other metal products, has had plans prepared for rebuilding its foundry, 44 x 100 feet.

Capitalized at $50,000, the Buffalo Brass Casting Corp., Buffalo, recently was incorporated to manufacture brass, bronze and other metal castings, by J. and G. Popp and C. Rosenberger.

Plans are being made by the Virginia Iron, Coal & Coke Co., Toms Creek, Va., to rebuild its foundry, machine shop and carpenter shop, which recently was damaged by fire.

Plans have been prepared for the erection of a foundry for the John J. Riley Co., Brooklyn, N. Y., which operates an iron and brass foundry on Van Brunt street.

The capital stock of the Rockford Union Foundry Co., 1129 River street, Rockford, Ill., recently was increased from $25,000 to $40,000. J. P. Lundell is president of the company.

The Akron Gear & Engineering Co., Akron, O., has under consideration the erection of a new plant. The company in addition to manufacturing gears, makes rubber machinery, tire cores and molds. L. A. Palmer is president.

The Hays Mfg. Co., Twelfth and Erie streets, Erie, Pa., manufacturer of brass and bronze products, has broken ground for the erection of an addition to its plant, 55 x 112 feet. William H. Foster is president of the company.

The Phoenix Foundry Co., Dallas City, Ill., will open a foundry in the building formerly occupied by the Northwestern Stamping Co., 800 Osborne street, Burlington, Iowa. Brass and aluminum ware will be cast.

The Wildman Mfg. Co., Norristown, Pa., manufacturer of machinery and parts, contemplates the erection of a new foundry and plant addition. Lockwood, Greene & Co., 101 Park avenue, New York, are architects.

Capitalized at $50,000, the Forest City Foundry Co., Rockford, Ill., recently was incorporated to manufacture castings, by Frank Johnson, Charles Johnson, Charles Leine, Otto Anderson, Carl Knutson and others.

The Newark, N. J. plant of the Crocker-Wheeler Co., Ampere, N. J., which has been used for the production of castings, has been placed on the market. The foundry comprises about 20,000 square feet of floor space.

The Gerlinger Steel Casting Co. and the Gerlinger Electric Steel Foundry Co., West Allis, Milwaukee, have been consolidated under the name of the Gerlinger Electric Steel Casting Co. with a capital stock of $500,000. Walter Gerlinger is secretary.

The Nelson Pulley Co., Milwaukee, recently was incorporated with a capital stock of $25,000, to manufacture transmission appliances, and to operate a foundry and machine shop, pattern shop, etc. The incorporators are Joseph E. Tierney, H. J. Ross and Frank J. Jennings.

M. G. Tennant, former manager of the Olympic Steel Works, Seattle, recently purchased the plant of the Malleable Steel & Iron Co., at 1163 Minneapolis street, Tacoma, Washington, and improvements are now being made to the plant, which will be operated under the name of the Tennant Steel Casting Co.

The Waterbury Farrell Foundry & Machine Co., Waterbury, Conn., has increased its capital stock from $440,000 to $2,500,000. The company manufactures machinery and castings, including hydraulic equipment, and recently established a plant at Buffalo. The company also started the construction of an addition to its plant at Waterbury, to be 43 x 180 feet.

By moving its offices into an adjoining building, the Plymouth Foundry & Machine Co., Plymouth, Wis., has gained considerable space which is being turned over to toolroom and stockroom purposes, for which new equipment has been purchased.

The Keeley Stove Co., Columbia, Pa., has had revised plans prepared for the erection of a new plant, 25 x 30 feet.

The Standard Malleable Co., Zanesville, O., has been incorporated with a capital stock of $100,000, to take over the plant of the Weidig Foundry Co. The company will specialize in the manufacture of malleable castings for radiators and will also make gray iron castings. The officers are: President, Eli A. Palmer; vice president, W. M. Bateman, and secretary-treasurer, A. L. Rea.

Capitalization of the United Machine & Mfg. Co., Canton, O., recently was increased to provide for the expansion to the company's present plant. The additional facilities will include a gray iron and semisteel foundry, which will have a capacity of from 25 to 50 tons daily. Additional machine tools and foundry equipment will be purchased within the next 90 days, according to L. E. Griffith, president of the company.

The Non-Ferro Foundry & Pattern Co., Toledo, O., has acquired the plant of the M. De Mers Blacksmith, Tool & Machine Co., and will operate a foundry and pattern shop. The company has increased its capital stock from $10,000 to $25,000. P. A. Gaynor is manager.

The Van Brunt Mfg. Co., Horicon, Wis., manufacturer of drills, seeders and agricultural implements, plans to increase the capacity of its plant by the erection of a foundry addition, 80 x 200 feet; a forge shop addition, 50 x 90 feet; a steel storage building, 40 x 150 feet and a dry kiln addition, 30 x 90 feet. It also plans to erect a steam generating plant addition, 50 x 60 feet. Fred H. Claussen is president and general manager.

New Trade Publications

TRUCKS.—The Available Truck Co., Chicago, has published a folder in which the specifications, etc., of trucks which it manufactures are given. The leaflet also contains line drawings of the truck.

REFRIGERATING PLANT.—Refrigerating plants designed for household service, are described and illustrated in a booklet recently issued by the Norwalk Iron Works Co., South Norwalk, Conn.

CHAIN BLOCKS AND TROLLEYS.—The Yale & Towne Mfg. Co., Stamford, Conn., has issued an illustrated booklet in which the use of chain blocks and trolleys in machine shops, is shown by a number of illustrations.

ELECTRODES.—The Acheson Graphite Co., Niagara Falls, N. Y., is circulating a leaflet in which attention is called to electrodes which it manufactures. The bulletin is a reprint of an advertisement which was published in a recent issue of *Chemical & Metallurgical Engineering*.

FOUNDRY EQUIPMENT.—Molding machines, both hand and air power, jolt stripping plate machines, core machines, lifting devices, piston machines, pouring devices, and other foundry equipment are described and illustrated in a 4-page folder being circulated by the Arcade Mfg. Co., Freeport, Ill.

DOOR OPERATOR.—The Loeb-Walters Co., Cleveland, is circulating a 4-page folder in which it describes and illustrates an automatic door operator for use in factories, warehouses, garages, etc., where opening and closing of large doors manually has been difficult. The device described is operated by air. Details are given.

ELEVATOR CONTROLLERS.—The Cutler-Hammer Mfg. Co., Milwaukee, has published a 24-gage illustrated booklet in which controllers for electric elevators are described and illustrated. The booklet points out the salient features of the controllers and gives full details, as to design, construction and operation.

BELT JOINING.—The Crescent Belt Fastener Co., 381 Fourth avenue, New York, recently has issued a booklet describing the application of its device. This booklet, entitled *Modern, Scientific Methods of Belt Joining*, contains practical information on up-keep and care to assure the best service from power belts.

SAND BLAST APPARATUS.—The injector sand blast apparatus is described and illustrated in a booklet being circulated by J. M. Betton, New York. This apparatus is adaptable for use with high or low pressure and may be used for cleaning castings of all kinds, metals for machining, removing paint, rust, etc. The booklet gives details as to construction and operation.

VENTILATING FANS.—An illustrated booklet has been issued by the Buffalo Forge Co., Buffalo, in which conoidal fans for use in ordinary heating and ventilating practice are described and illustrated. This fan is of the multiblade type, having blades of single curvature conforming to the surface of the cone. Full descriptions of the various parts of the fan are given, and the booklet also contains tables of performances which should be of aid to engineers and architects in making fan selections.

PNEUMATIC TOOLS.—A 124-page illustrated catalog is being circulated by the Keller Pneumatic Tool Co., Grand Haven, Mich., in which pneumatic riveting, chipping, calking, flue-beading and scaling hammers; pneumatic dolly bars, holders-on, jam riveters, rivet busters and sand rammers, as well as pneumatic valveless and corliss valve piston drills, wood boring machines, grinders and various accessories and parts of pneumatic tools are described and illustrated. The booklet gives specifications and other data.

PIPE WELDING.—The Metal & Thermit Corp., New York, has issued and will distribute on request the third edition of its pipe welding pamphlet No. 16. The new pamphlet describes and illustrates in detail how thermit pipe welds are made and contains reports on tensile strength and vibration tests of pipe welds conducted by Stevens Institute. One of the features of the new pamphlet not published in former editions is a chart showing the comparative cost of a welded pipe with the cost of installing compression flanges with bolts and gaskets and of installing elbows with flanged connections. The new edition also contains an account of a 10-year pipe test at West Albany, N. Y., during which 700 feet of 4-inch extra heavy welded pipe, which connected a power house of the New York Central Lines with a boiler house, was constantly subjected to a hydraulic pressure of 1500 lbs. to the square inch.

ROTARY POSITIVE BLOWERS.—A second edition of its catalog on rotary positive blowers has just been issued by the P. H. & F. M. Roots Co., Connersville, Ind., 48 pages printed on fine stock, covered with heavy embossed paper. As in the first edition space formerly given to engravings of blower installations has been used for engineering data. These data are full and designed to give users of blowers full information when ordering equipment to match their needs. Clear explanation is made of the operating principle of the blower, with diagrams and the catalog then passes to descriptions of the various types of blowers and their parts, as well as the materials of which they are constructed. Halftones of the several types are presented. Full instructions, illustrated by a table of sizes, are given for selection of a foundry blower, for those used in connection with oil and gas furnaces and steel converters. Full explanation is made of couplings and vales. Graphs make it easy to determine air velocities, pipe friction and flow through orifice.